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COMPREHENSIVE BASIN STUDY. BIG MUDDY RIVER, ILLINOIS. VOLUME 7.--ETC(U)
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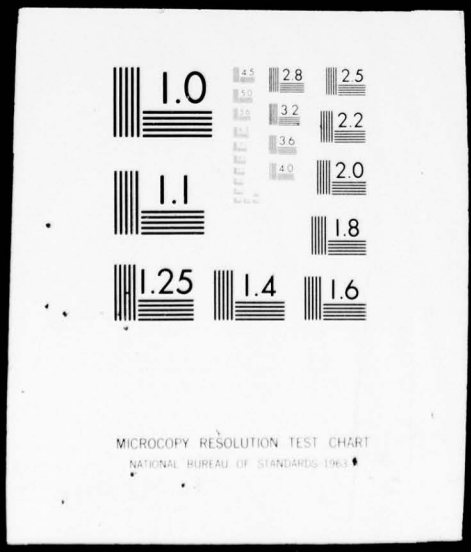

BIG MUDDY RIVER.

Illinois.

Comprehensive Basin Study.

Volume 7.

Appendix M and N.

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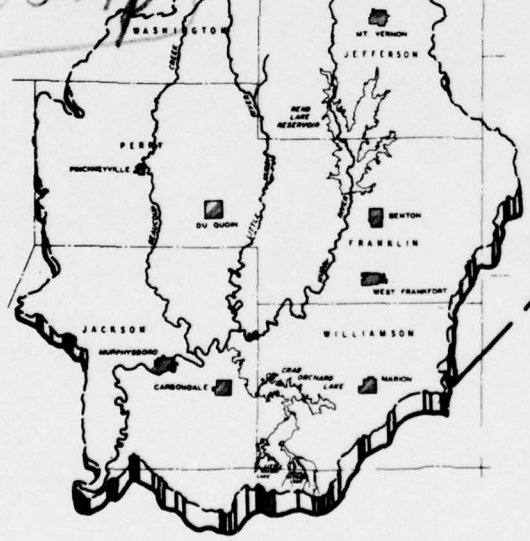
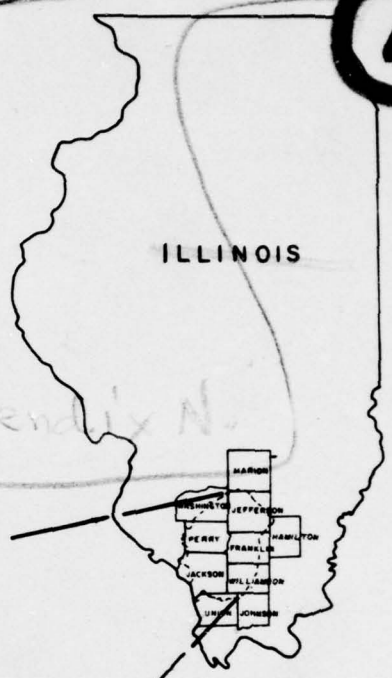




APPENDIX M
APPENDIX N

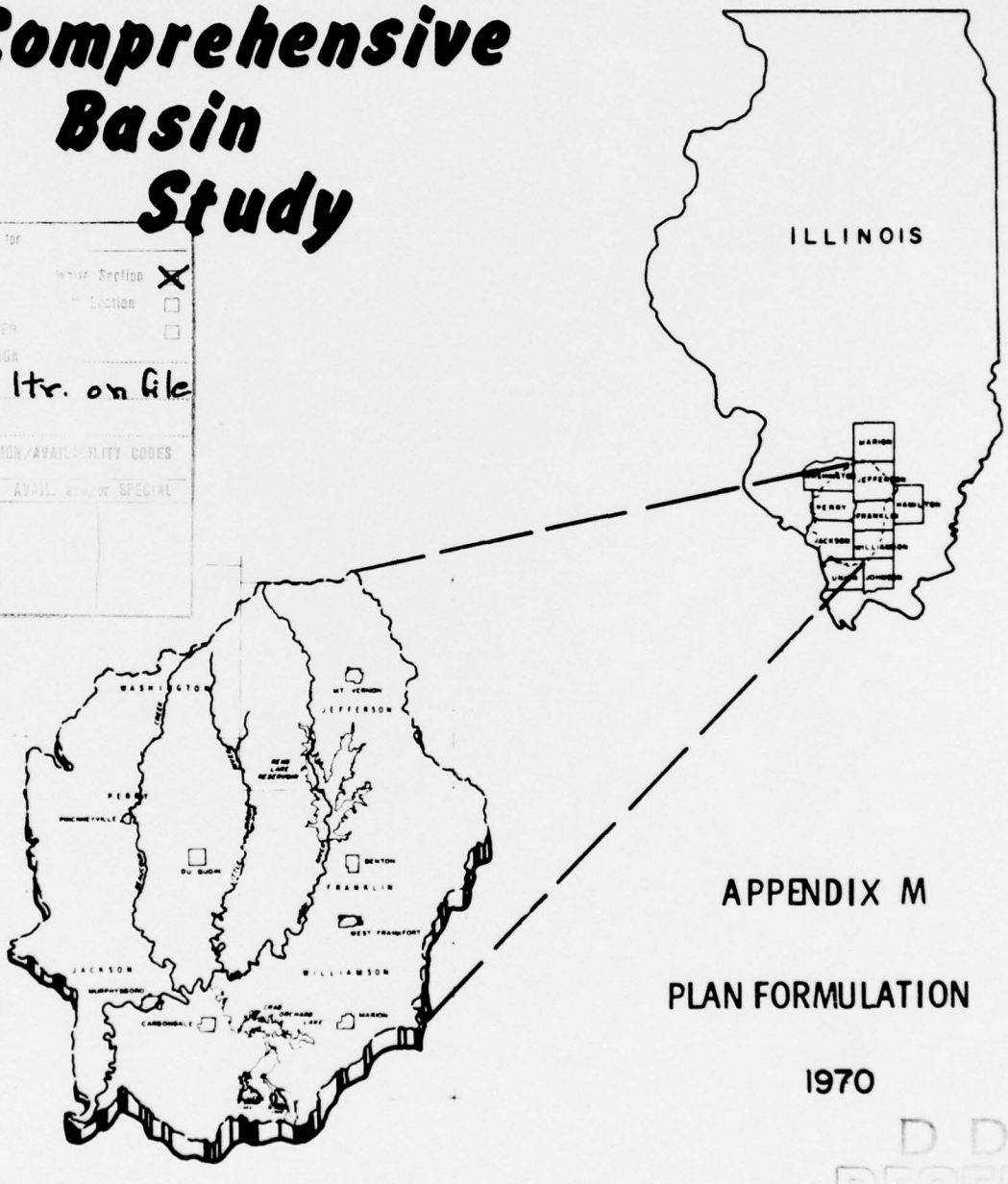
1971

Prepared under supervision of

Big Muddy River Basin Coordinating Committee

BIG MUDDY RIVER

Comprehensive Basin Study



APPENDIX M

PLAN FORMULATION

1970

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

Prepared by Corps of Engineers
in Cooperation with the Plan Formulation Committee
composed of representatives from:
U. S. Departments of Agriculture, Army, Commerce and Interior; Federal Power Commission;
and Department of Business and Economic Development, State of Illinois

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PLAN FORMULATION

SECTION I - INTRODUCTION

1. PURPOSE

The purpose of this REPORT is to present the policies, standards and procedures used in the formulation and selection of the individual projects recommended for development in the Big Muddy River, Illinois, Basin. The basin plan is designed to meet the present and projected water-related, land-related, and socio-environmental needs for the next 50 years. These needs include flood control, drainage, land treatment to minimize erosion and sediment losses, low-flow augmentation, water- and land-related outdoor recreation, wildlife conservation and quality improvement of stream fisheries, redevelopment of the area's economic structure, and environmental quality control. The plan is developed in sufficient detail to serve as the basis for obtaining congressional authorization of those projects required within the next 10-15 years, as well as providing a flexible framework for long-range development and growth.

2. SCOPE

a. General. The basic objective in formulating the plan of improvement was to provide the best use, or combination of uses, of water and land resources to meet all foreseeable short- and long-term needs. Before this objective could be achieved, however, the needs had to be defined relative to the basin's role and contribution for meeting stated national and regional objectives. This first level of consideration would, in turn, establish a second level framework within which the functional relationship of any proposed development could be compared.

b. First level of consideration. The Big Muddy River Basin is part of one of 16 planning areas that comprise the Upper Mississippi River Basin. This latter geographic unit has been defined by the Office of Business and Economics, Department of Commerce, as one of 16 continental demographic and economic regions established to facilitate the nation's planning and development. While the studies for the two basins - Upper Mississippi River (Type I) and the Big Muddy River (Type II) - were both authorized and funded somewhat concurrently, the detailed evaluation for the Type II study was delayed until the basic regional framework had been established. This insured that any selected plan of improvement concerning local resource use would properly contribute to an accepted regional plan of development reflecting national and regional goals. The regional evaluation was governed by two basic objectives:

(1) The national objective which strives to increase national income through investments in those water-and land-resource developments which are also responsive to the commitment for enhancing both the environmental quality and social well-being; and,

(2) The regional objective which requires that the resource developments provide the allocated share of the national needs, but within a framework of regional viewpoints and physical constraints.

The regional analysis established a framework for resource commitments. It was the result of an interrelated evaluation, balancing the region's objectives and its relative service-market relationship to the nation and national objective of maximum economic efficiency and human satisfaction. In all cases, the product or service output was analyzed to insure a positive economic contribution and not a redistribution or shift-share of the national market. The regional pattern of development was expressed in terms of projected population and industrial characteristics. The conclusions were based on such considerations as resource capability, preemptive use or competitive market value of resource commitment per subregional planning area, local needs, personal income, and population growth patterns. All of these analytical considerations reflected the region's individual subplanning area characteristics and the various States' proposals for development.

c. Second level of consideration. Based on the foregoing, it was recognized that the plan formulation procedures utilized in this Type II study had a basic constraint, i.e., the area's allocated (disaggregated) share of the region's service-market role and the demographic and economic distribution pattern. However, it was assumed that the framework of need and output was flexible; that adjustments could be made to reflect a maximization (economic efficiency) of resource commitment; and action programs could be formulated to satisfy specific resource deficiencies from other subregional planning areas, provided a comparable service-market relationship was maintained. Thus, the plan formulation process for this basin study was simply divided into a two-step procedure:

(1) To provide the projected resource development and economic requirements established by the national and regional objectives; and,

(2) To insure that the level of need satisfaction provided included aesthetic and socio-environmental considerations.

This procedure requires that all projects, Federal and non-Federal, constructed, under construction, or planned, be considered in the planning process. Furthermore, it becomes mandatory that the performance standard or output be balanced against the desires for social change and the need for environmental control.

3. RELATIONSHIP TO OTHER APPENDICES

The analytical procedures and conclusions presented in this appendix were based on the physical and socio-economic data established in the other 13 appendices that represent the total multi-disciplinary input for this study. To assure the successful development of a fully correlated and comprehensive basin plan, the formulative and selective procedures were prepared under the supervision of a Plan Formulation Work Committee composed of representatives from selected agencies. TABLE 1 lists the various appendices and the agencies with primary responsibility for their preparation. TABLE 2 lists the various Federal and State agencies and local entities that participated in the formulation of the basin plan.

4. EXISTING PROJECTS

Water- and land-related improvements developed by Federal and non-Federal interests are scattered throughout the basin and generally have been built for restrictive and special usage. The most significant of these projects are summated in TABLE 3. The tabulation is confined to only the five counties, the major portions of which are located within the basin boundaries. No attempt has been made to list all projects. Rather, coverage is limited to those projects which have a significant impact on the demands, needs, and potential development of the area's water and land resources. More detailed coverage is presented in the various supporting appendices.

TABLE M-1

Appendices

Appendix	Title	Responsible Agency
A	Climatology, Meteorology, & Surface Water Hydrology	Corps of Engineers
B	Availability of Groundwater	Geological Survey
C	Mineral Resources	Bureau of Mines
D	Fluvial Sediment	Corps of Engineers
E	Water Use and Stream Quality	Federal Water Pollution Control Administration *
F	Flood Control and Drainage	Corps of Engineers
G	Navigation	Corps of Engineers
H	Recreation	
	Part 1 - Natural, Historical and Archaeological Resources	National Park Service
	Part 2 - Water-Oriented Outdoor Recreation	Bureau of Outdoor Recreation
I	Fish and Wildlife Conservation	Fish and Wildlife Service
J	Power	Federal Power Commission
K	Agriculture	Soil Conservation Service
L	Economic Base Survey	Corps of Engineers
M	Plan Formulation	Corps of Engineers
N	Benefit Evaluation	Corps of Engineers

* Effective 2 December 1970, part of Region V, Water Quality Office, U. S. Environmental Protection Agency.

TABLE M-2

Plan formulation committee

Members		Participants
1. Department of Agriculture	-	Soil Conservation Service
2. Department of Army	-	Corps of Engineers
3. Department of Commerce	-	Environmental Sciences Service Administration
4. Federal Power Commission	-	Federal Power Commission
5. Department of Interior	-	a. Regional Coordinator
	-	b. Federal Water Pollution Control Administration
	-	c. Bureau of Outdoor Recreation
	-	d. Bureau of Sport Fisheries and Wildlife
6. State of Illinois	-	Department of Business and Economic Development
7. Local interests	-	Greater Egypt Regional Planning and Development Commission
		Rend Lake Conservancy District (associate)
		Kinkaid-Reeds Creek Conservancy District (associate)

TABLE M-3

Existing resource developments

County and Project	Water Acres	Land (1) Acres	Total Acres	Purpose (2) Served
1. Franklin County				
Rend Lake - (under construction)	18,900	20,760	39,660	(3)
West Frankfort New Res.	200	----	200	Rec, F&W, WS
Lake Moses	170	----	170	Rec, F&W, WS
West Frankfort Old Res.	150	----	150	Rec, F&W, WS
Club Waters - 5	160	----	160	Rec, F&W
2. Jackson County (5)				
Kinkaid Lake - (under construction)	2,700	2,700	5,400	Rec, FC, WS, F&W
Lake Murphysboro State Park	170	740	910	Rec, F&W
Carbondale City Lake	140	----	140	Rec, F&W, WS
Club Waters - 5	140	----	140	Rec, F&W
Giant City State Park	----	1,800	1,800	Rec, F&W
Oakwood Bottoms Greentree Res.	----	2,600	2,600	Rec, F&W
Cedar Crk. Res. No. 1 (4)	160	----	160	F&W, WS, FC
Cedar Crk. Res. No. 2 (4)	1,060	200	1,260	Rec, F&W, WS, FC
3. Jefferson County				
Mt. Vernon State Game Farm	10	590	600	Rec, F&W
Miller Lake	140	----	140	Rec, F&W
Mt. Vernon Reservoir	130	----	130	Rec, F&W, WS
Bluford Rod & Gun Club	100	----	100	Rec, F&W
4. Perry County				
DuQuoin State Fairgrounds	----	1,400	1,400	Rec
DuQuoin Reservoir	320	----	320	Rec, F&W, WS
Pinckneyville Reservoir	170	----	170	Rec, F&W. WS
5. Williamson County (5)				
Crab Orchard National Wildlife Refuge	----	13,610	22,390	Rec, F&W
Crab Orchard Lake	6,970	----	----	Rec, F&W,WS
Little Grassy Lake	1,000	----	----	Rec, F&W
Devil's Kitchen Lake	810	----	----	Rec, F&W
Lake of Egypt - (also Johnson County)	2,400	----	2,400	Rec, F&W,WS
Club Waters - 14	160	----	160	Rec, F&W
Marion Reservoir	130	----	130	F&W,WS

TABLE M-3 (cont'd)

Existing resource developments

Note (1) Land acreage listed only when considered to be one of the basic resources involved.

Note (2) Abbreviations used:
Rec - general recreation water and/or land related;
F&W - fish and/or wildlife conservation;
WS - water supply;
FC - flood control.

Note (3) Rend Lake - Rec, F&W, WS, FC, low-flow augmentation (water quality), area redevelopment.

Note (4) Approved by the Governor, State of Illinois, for construction under Public Law 566. Construction contingent upon local participation.

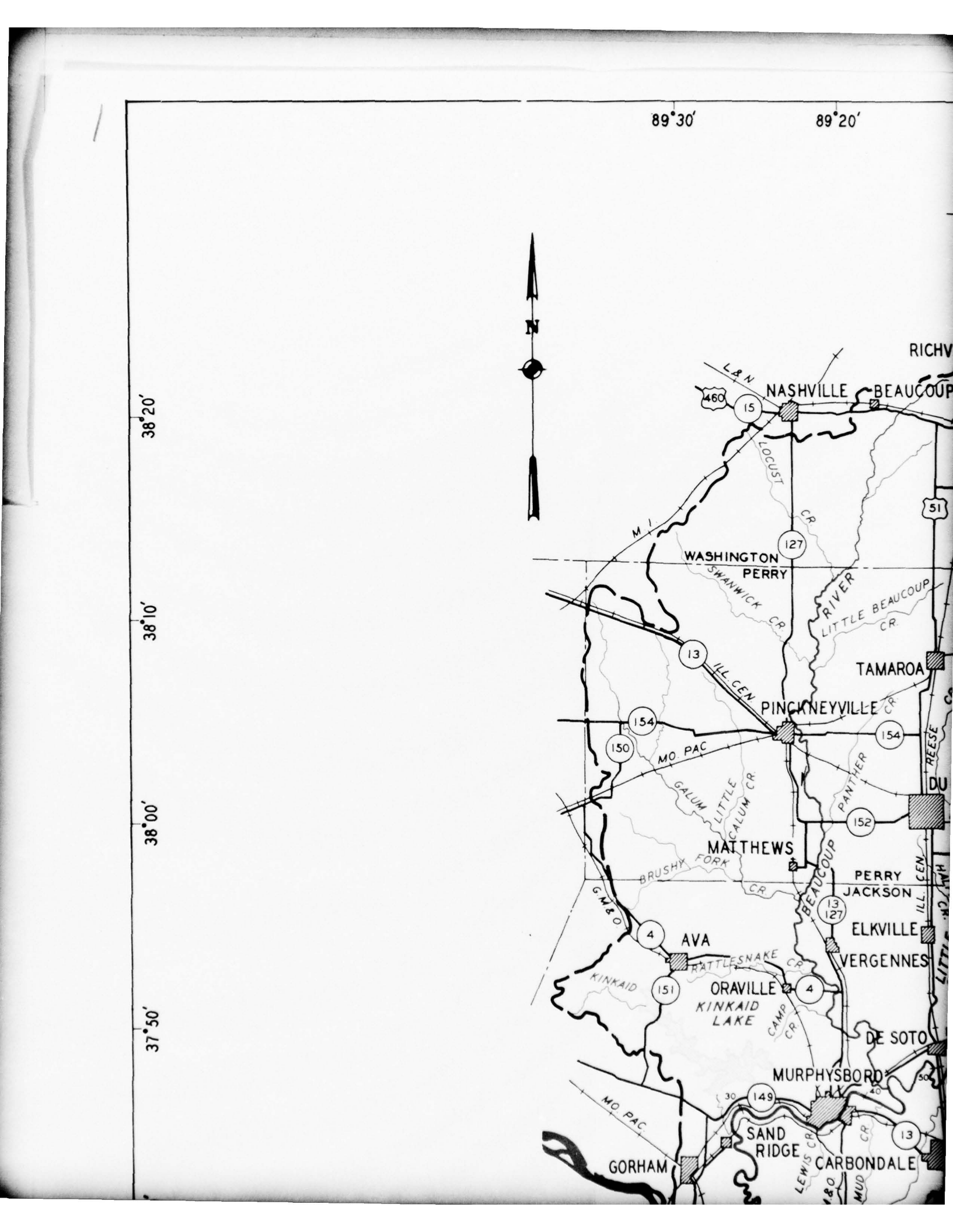
Note (5) Located within this county is a portion of the 29,560 acres of Shawnee National Forest lands lying within the basin boundaries.

SECTION II - BASIN NEEDS

5. PLANNING ENVIRONMENT

a. Description. The Big Muddy River Basin embraces major portions of Franklin, Jackson, Jefferson, Perry and Williamson Counties and small portions of Hamilton, Johnson, Marion, Randolph, Union and Washington Counties. The basin contains some 2,375 square miles and is essentially rectangular in shape, having a median length of 72 miles and an average width of 33 miles. The topography is characterized by gently undulating hills in the north and west; low relief, wide valleys, and well developed upland drainage system in the east; and more rugged well-defined hills and valleys in the south. Local topographic relief seldom exceeds 100 feet with elevations ranging from 320 to 860 feet above mean sea level. A map of the basin is shown on PLATE 1.

b. Climatology, hydrology, and hydraulic characteristics. The basin area has a climate that is typical of the mid-Mississippi River Region. The winters are relatively mild while the summers are commonly warm-to-hot and usually humid. Mean annual temperature is approximately 60° Fahrenheit with extremes of 114° to -20° having been recorded. July is the warmest month and January is the coldest month, with mean monthly temperatures equivalent to 78° and 36°, respectively. Due to the moderate temperatures, the area has a frost-free growing season of some 190-200 days. Average annual rainfall in the basin is about 42 inches as compared to the United States average of some 30 inches, with extremes of 65 and 29 inches having been recorded. Average annual snowfall is about 13 inches. Average annual runoff for the period of record represents about 11.5 to 13.0 inches average depth over the drainage area, or about 1,500,000 acre-feet. The drainage system consists of the main stem of the Big Muddy River and its five principal tributaries: Beaucoup Creek, Crab Orchard Creek, Little Muddy, Middle Fork, and Casey Fork. The basin has been divided into 15 major tributary areas or watersheds based on topographic and hydraulic considerations. The 15 watersheds are shown on PLATE 2. Stream flow data on the Big Muddy has been collected intermittently from 1908 to date. The Plumfield gage on the main stem, which has a drainage area of 785 square miles, was selected as the control or reference gage since it has the longest period of record and was also representative of the basin's flow pattern and yield. During the period of record, extending from 1916 to 1965, Plumfield gage has recorded a mean discharge of 713 c.f.s. with a maximum and minimum flow of 43,500 and 0, respectively. Low-flow characteristics indicate an annual critical 7-day low-flow averaging 2 c.f.s. or less per day in 25 of the 50 years of record. Annual yield in acre-feet for the Plumfield gage has equaled or exceeded 513,000, 50 percent of the time; 170,000, 90 percent of the time; and, 63,000, 95 percent of the time.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ELKVILLE
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AVA
VERGENNES
RATTLESNAKE CR.
KINKAID
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ORAVILLE
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KINKAID LAKE
CAMP CR.
DE SOTO
MURPHYSBORO
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GORHAM
CARBONDALE
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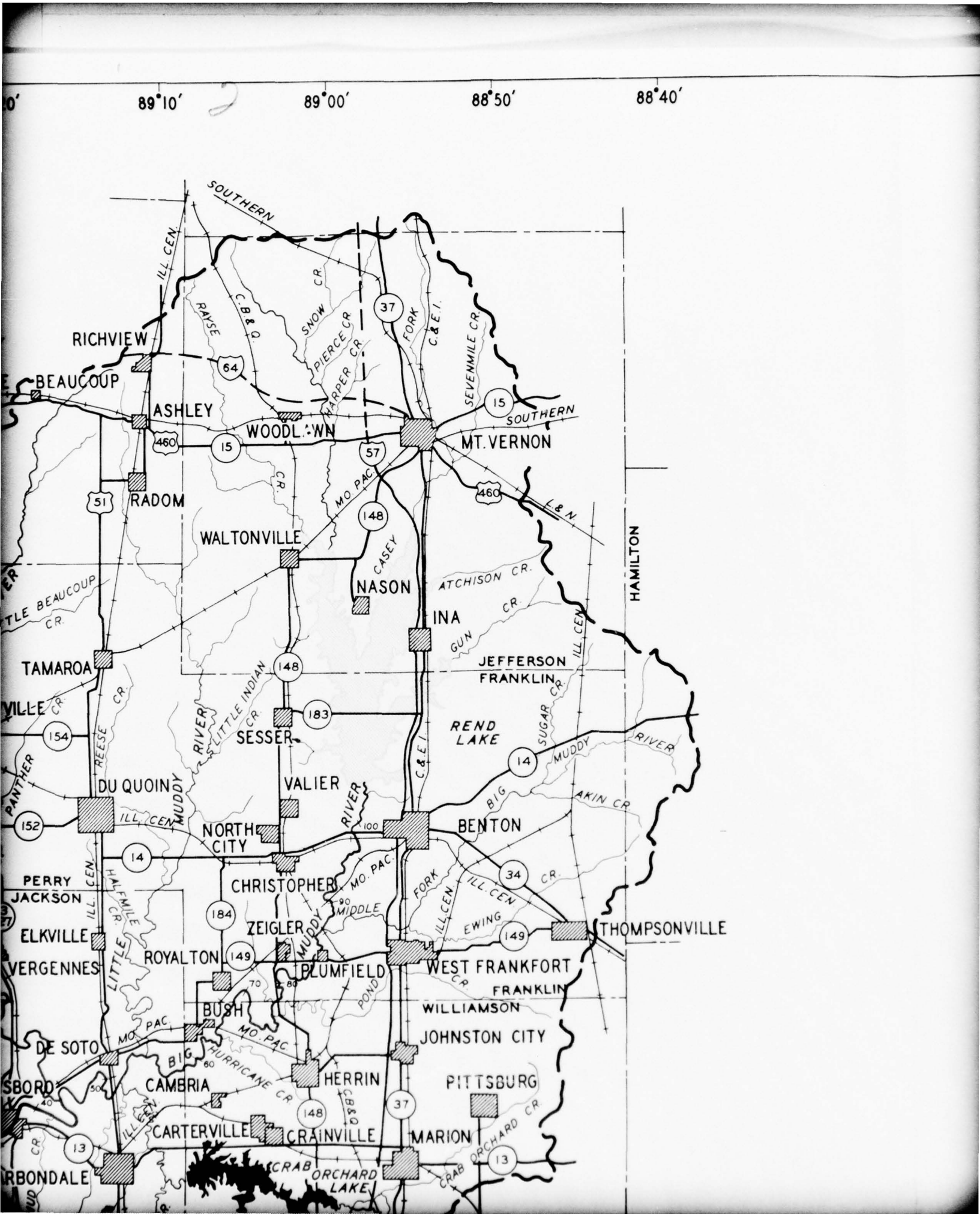
MUD CR.
M & O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BEAUCOUP
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WOODLAWN
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MO. PAC.
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HAMILTON
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SUGAR CR.
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PANTHER
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VALIER
BIG AKIN CR.
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NORTH CITY
PERRY
JACKSON
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CHRISTOPHER
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FORK
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CR.
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ZEIGLER
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CRAB ORCHARD CR.
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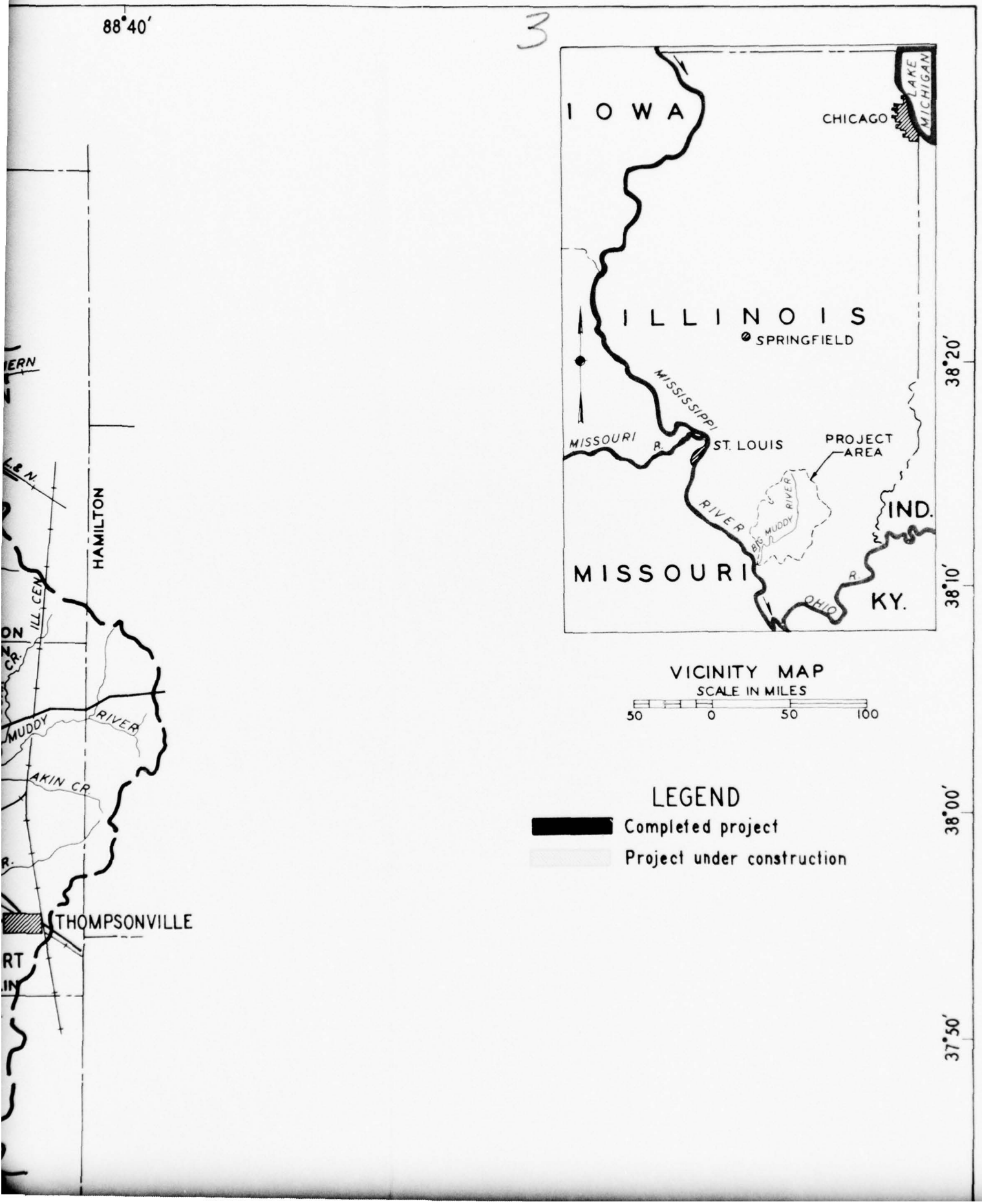
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ST. LOUIS
PROJECT AREA
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BIG MUDDY RIVER
IND.
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VICINITY MAP
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LEGEND
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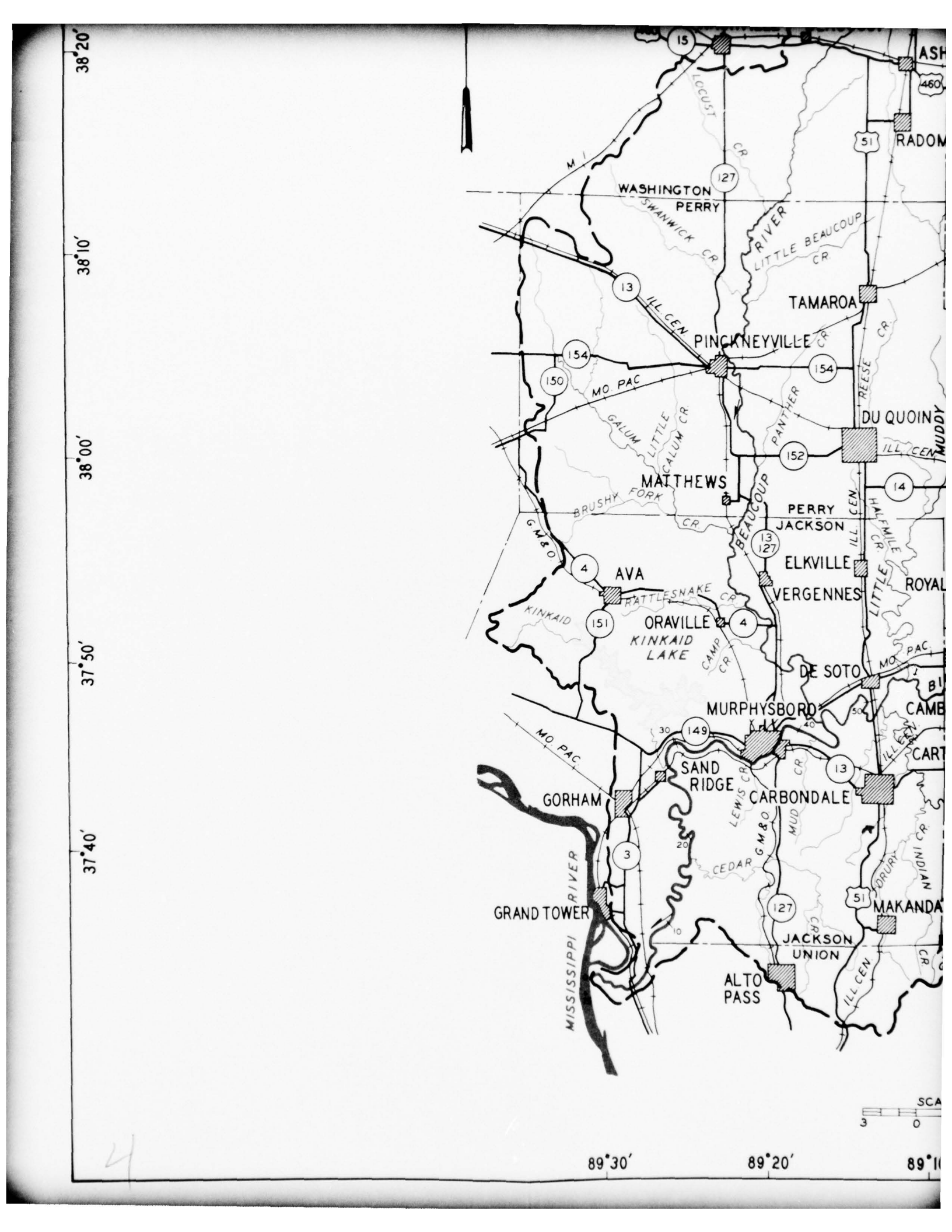
ILL. CEN.
MUDDY RIVER
AKIN CR.
THOMPSONVILLE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MUD CR
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GM&O
INDIAN CR
DRURY
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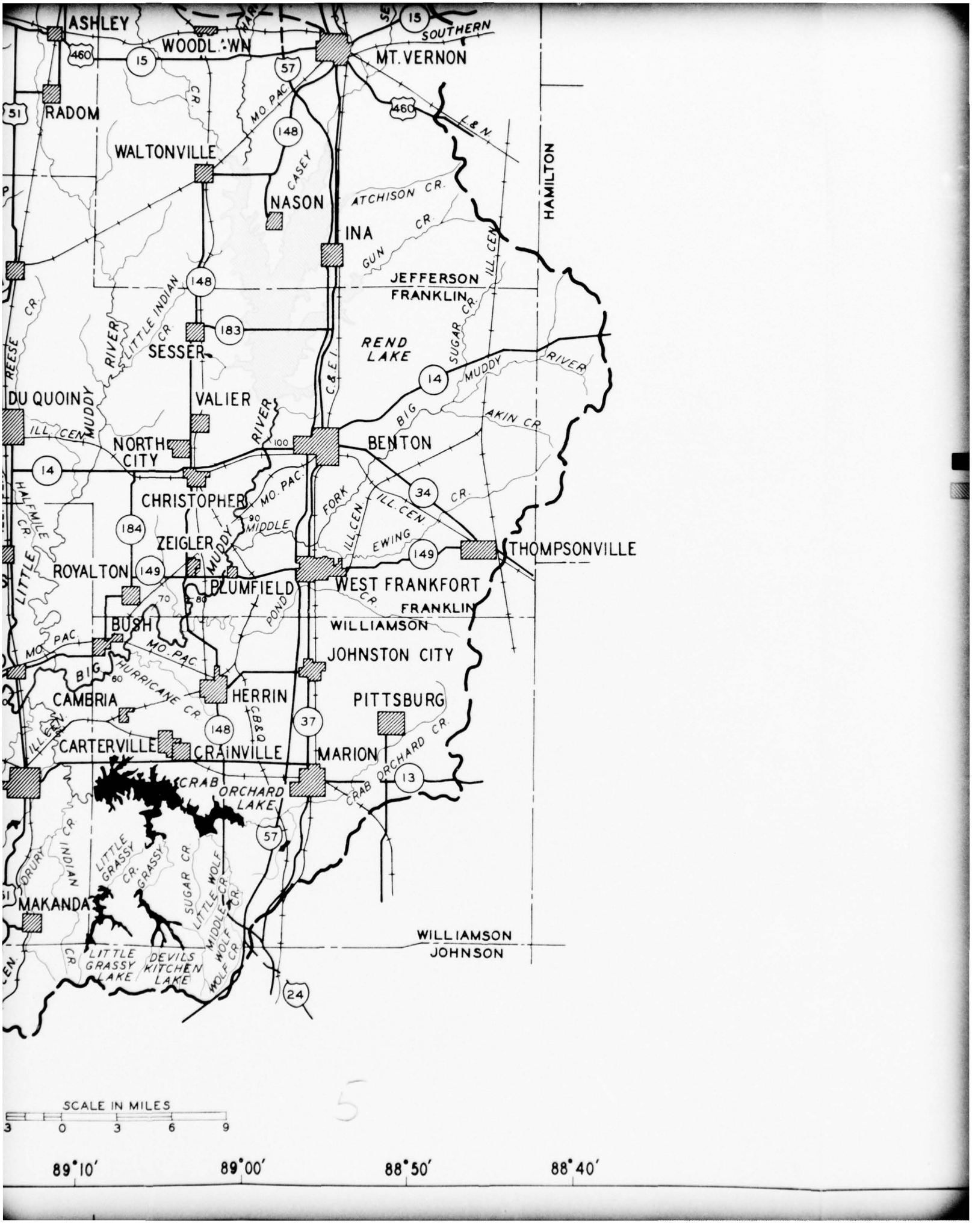
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MARION
CRAB ORCHARD LAKE
MAKANDA
WILLIAMSON
JOHNSON
LITTLE GRASSY LAKE
DEVILS KITCHEN LAKE
MO. PAC.
ILL. CEN.
C. & E. I.
L. & N.
C. B. & Q.
MUDDY RIVER
BIG MUDDY RIVER
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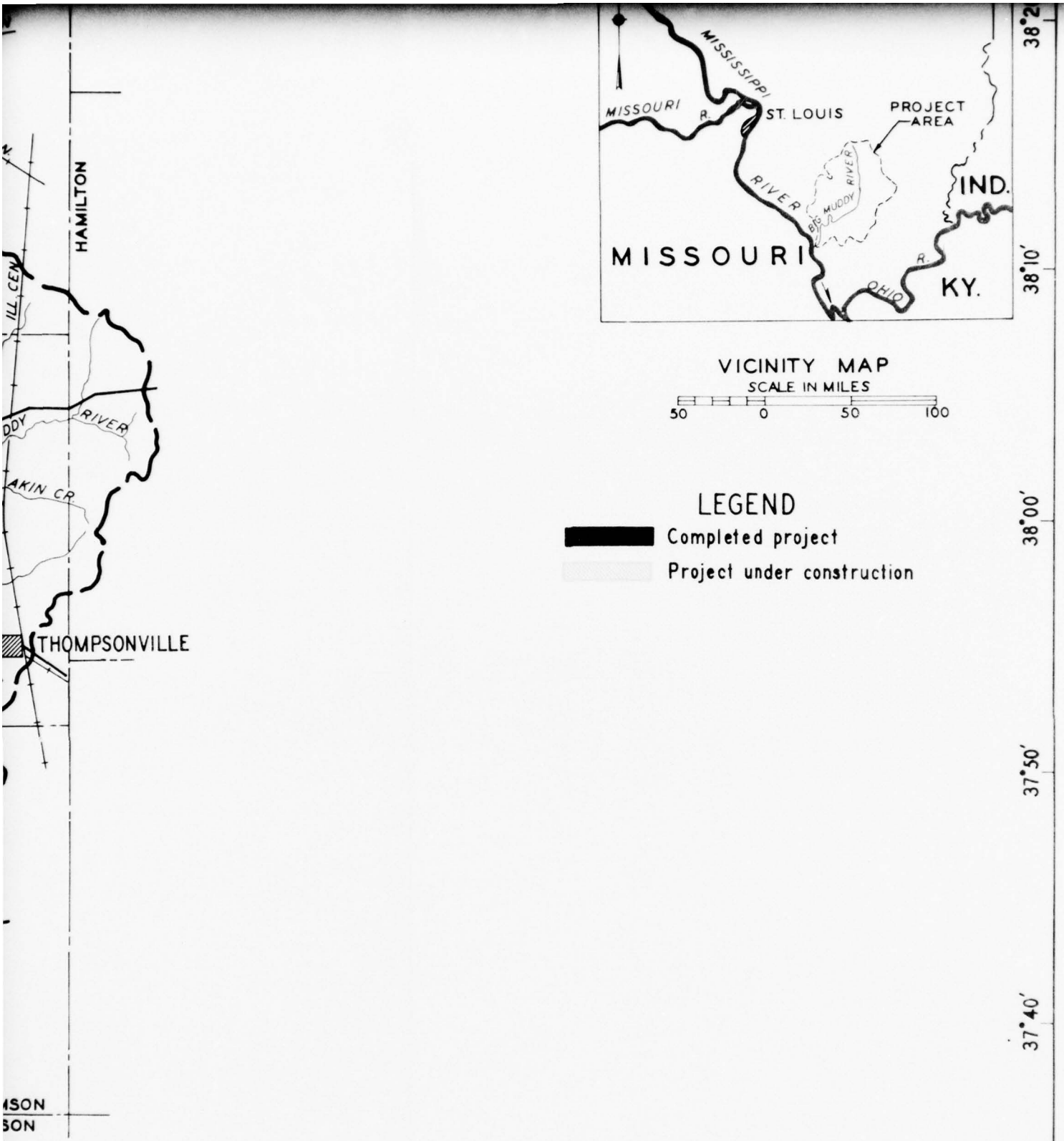
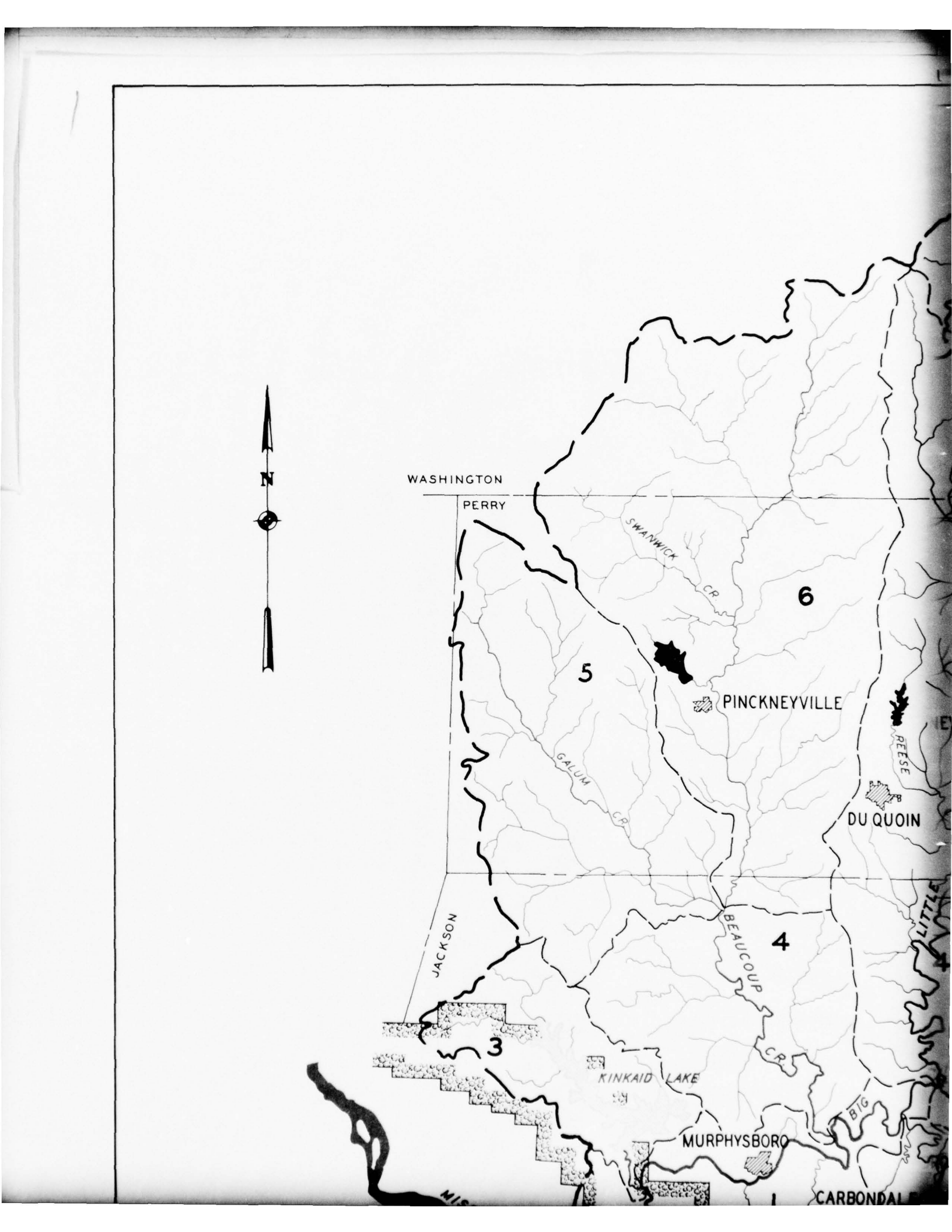


BASIN MAP
BIG MUDDY RIVER BASIN, ILLINOIS

6

PLATE 1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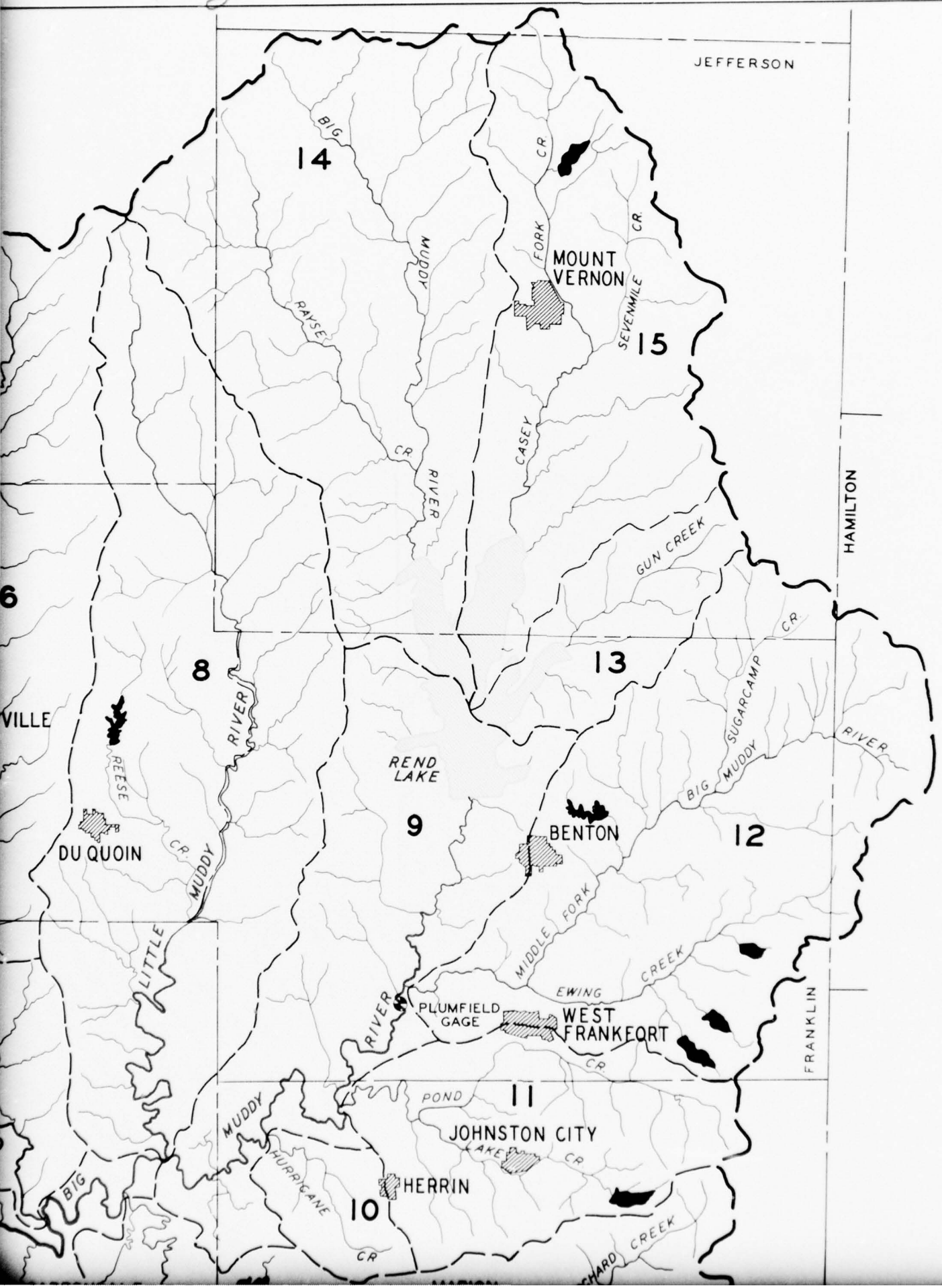
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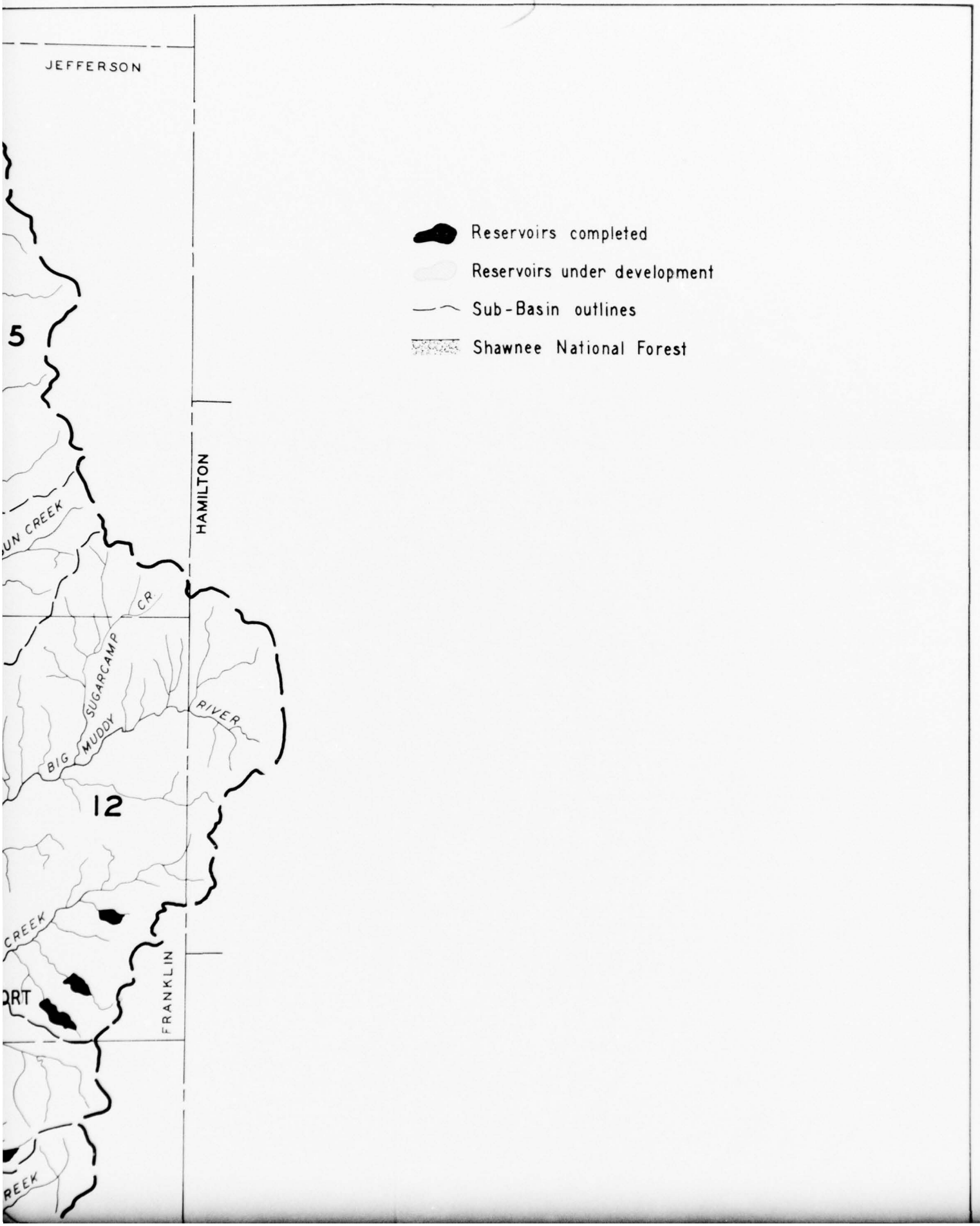
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CREEK
RT
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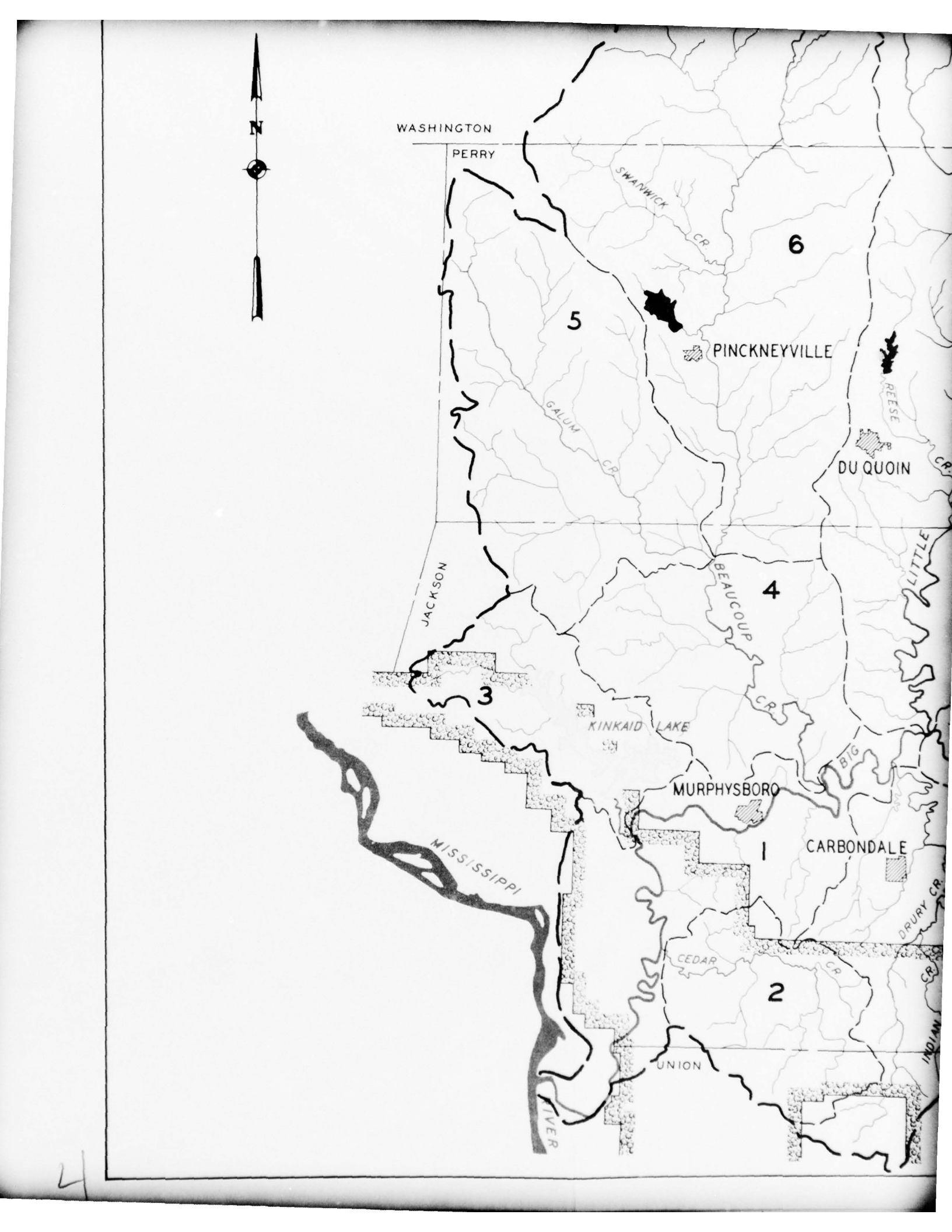
Reservoirs under development
Sub-Basin outlines
Shawnee National Forest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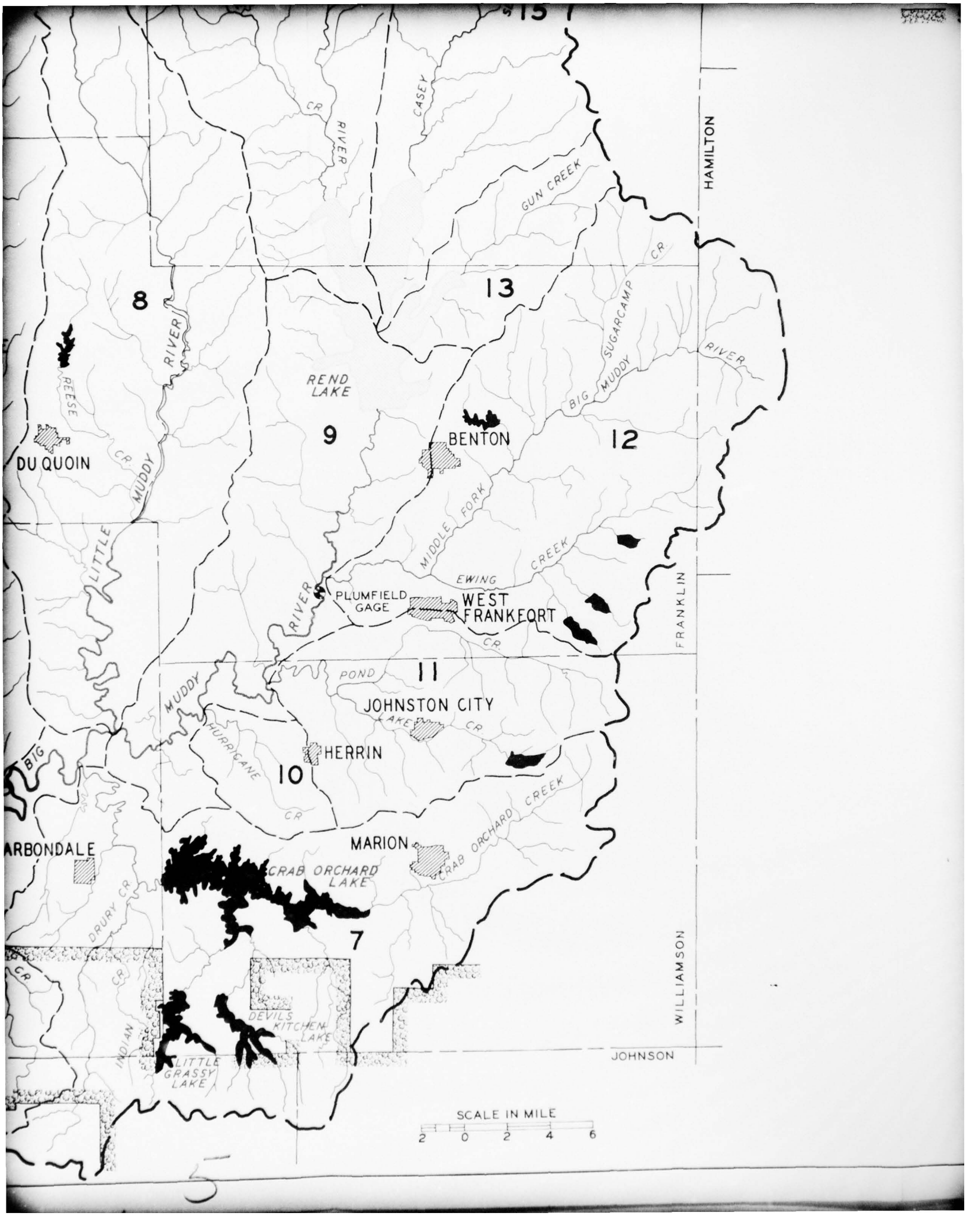
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LAKE
CR.
HURRICANE
CR.
HERRIN
10
BIG
CR.
CRAB ORCHARD CREEK
ARBONDALE
MARION
CRAB ORCHARD
LAKE
DRURY CR.
7
CR.
CR.
DEVILS
KITCHEN
LAKE
INDIAN
LITTLE
GRASSY
LAKE
WILLIAMSON
JOHNSON
SCALE IN MILE
2 0 2 4 6

TRIBUTARY STREAMS AND WATERSHEDS
BIG MUDDY RIVER BASIN, ILLINOIS

c. Land use. There are approximately 1,520,000 acres within the basin area of which approximately 52 percent is in croplands, 13 percent in pasture, 18 percent in forest lands, and 17 percent in other uses. Approximately 317,000 acres, or about 21 percent of the basin area, is located in the flood plains with 52 percent in agricultural production, and the remaining 48 percent essentially in woodlands. Some 29,560 acres of the Shawnee National Forest is included in that part of Jackson, Williamson, and Union counties located within the Big Muddy River Basin. A breakdown of the land use in each of the 15 watersheds is shown in TABLE 4.

d. Mineral resources. Principal mineral resources found in the basin are coal, petroleum, sand and gravel, clay and shale, and stone. The first two are actively under production and generally shipped to markets outside the basin. Sand and gravel and stone outputs are generally limited to the needs of the local area in which they are produced. As far as is known, there has been no commercial mining of clay and shale since 1953. Both strip and underground mining methods are used in the production of coal. Strip mining began in the basin about 1910 and is still used today. With the advent of improved design and development of large earth-moving equipment, strip mining accounted for some 33 percent of the basin's 1960 total coal production. Secondary recovery methods, involving water pumped under pressure through properly located input wells, accounted for 23 percent of the basin's 1960 crude oil production.

e. Natural environment. Because of its climatic make-up and its geographical location, the basin has mixed species of flora and fauna, which are representative of both northern and southern climates, and also contribute to an environment conducive to outdoor pursuits. Native to this basin is a remarkable array of animal life. Of the 59 species listed as native to Illinois, 46 can be found within the drainage area. A variety of migratory waterfowl, including several species of geese and ducks, is also common to this area, which is part of the Mississippi Flyway. Due to sediment and other pollutants, most of the streams in the basin are dominated by rough fish. However, where water quality is better, especially in the man-made improvements, the predominant species include game fish. Moderate temperatures in the spring and fall tend to promote a recreational season extending from 1 April through 30 November, which is well beyond the traditional 3-month period common in the northern region of the State. Concentrated within this 8-month period are the peak demands for general recreation, fishing, and selected hunting. While these pursuits are complementary and concurrent, their peak demands occur at different times. Peak demand for general activities such as boating, camping, picnicking, swimming and hiking is from 15 April through 15 September, and for fishing from 1 April through 15 June and from 15 September through October. Hunting demands vary depending upon the species being sought, but they are generally the heaviest during the late fall and winter months, 15 October through February.

TABLE M-4

LAND USE BY WATERSHED
(ACRES)

Watershed	Crop-land	Pasture-land	Forest-land	Other Land 1/	Total
No. 1 Lower Big Muddy	22,010	7,600	21,830	23,700	75,140
No. 2 Cedar Creek	15,120	4,820	13,130	10,450	43,520
No. 3 Kinkaid	16,940	5,330	13,960	4,730	40,960
No. 4 Lower Beaucoup	31,430	9,840	21,210	2,800	65,280
No. 5 Galum Creek	62,330	13,590	15,050	13,350	104,320
No. 6 Upper Beaucoup	128,625	21,885	24,830	22,200	197,540
No. 7 Crab Orchard	62,730	20,420	36,200	66,670	186,020
No. 8 Little Muddy	107,680	23,700	30,810	20,190	182,380
No. 9 Central Big Muddy	58,950	11,780	22,290	9,380	102,400
No. 10 Hurricane Creek	7,900	2,290	3,360	1,810	15,360
No. 11 Lake & Pond	34,180	9,150	14,020	7,290	64,640
No. 12 Middle Fork	85,380	24,150	22,170	21,040	152,740
No. 13 Gun Creek	17,310	4,680	4,890	4,480	31,360
No. 14 Upper Big Muddy	84,120	25,580	17,870	26,450	154,020
No. 15 Casey Fork	54,030	18,930	11,760	19,600	104,320
TOTAL: acres	788,735	203,745	273,380	254,140	1,520,000
percent	52	13	18	17	100

1/ Includes urban, industrial areas, State and Federal lands (including 63,030 acres of public-owned forests), farmsteads, roads, and other miscellaneous land.

6. FRAMEWORK FOR NEED EVALUATION

The Big Muddy River Basin is essentially rural in character, moderately populated, and contains few urban areas of large size. Employment in mining and agriculture, historically the two principal industries, has steadily declined. Out-migration has been experienced in the three and one-half decades since 1930. Unemployment rates historically have been high, and the Federal and State governments have worked with local interests to improve the area's economic situation. Specific Federal water-related input to the basin's economic redevelopment was initiated when the U. S. Congress authorized construction of the Rend Lake Dam and Reservoir by the Corps of Engineers. The evaluation of this multiple-purpose reservoir recognized the area's redevelopment as a legitimate project purpose, the worth of which reflected the value of water-related developments in reorienting the local economic structure. Furthermore, the State of Illinois, in cooperation with the U. S. Forest Service, has initiated construction of Kinkaid Lake, a multiple-purpose project, to meet a portion of the area's future needs. This reservoir is in addition to previous State assistance provided in construction of other local flood control and drainage projects. At the same time, the five local counties in the study area have joined together to form a regional planning group known as The Greater Egypt Regional Planning and Development Commission. Four of the five counties have already established and adopted a land-use plan that will insure a proper framework for development. A land-use plan for the fifth county, Jefferson County, was completed in May 1970, but has not yet been approved. The State of Illinois, particularly through its Southern Regional Office of the Department of Business and Economic Development, has been working very closely with local interests in an effort to stabilize the economic structure and reverse the trends of out-migration. While success has been slow, the area has now progressed to a level of public awareness and capability to insure continued progress. However, it still lacks certain resource inputs required to attain the basin's target level of economic development. To properly estimate this level of future development, an economic base survey was made of the five core counties and the eight peripheral counties. These counties comprise a major part of southern Illinois, an area which the State tends to treat as a total economic subregion. The economic forecast was developed from an analysis of three economic indicators: population, employment, and personal income. Projections of these indicators were compared to those contained in the Upper Mississippi River Comprehensive Basin Study (Type I); and appropriate adjustments made to reflect the Big Muddy's economic standing relative to both the regional and national projections and objectives. The short- and long-range demands for products and services associated with the basin resources were then evaluated, based on and within the framework of these three indices. This analysis was divided into three categories: water-related resources, land-related resources, and socio-environmental considerations. This approach permitted subsequent planning objectives to be more realistically defined and

permitted formulations of projects, or groups of projects, to be more comprehensive and responsive to needs. In all cases, the projected demands for various products and services were compared to the effective supply of existing and authorized projects, either under construction or in preconstruction planning. This comparative evaluation then identified the following needs as requiring some form of action program.

7. FLOOD CONTROL

To properly evaluate the flood water damages, it was recognized that a prototype study of a "typical" watershed(s) would be required in order to obtain a meaningful analysis. However, before this could be accomplished, it was necessary to ascertain the degree of effective flood control that would warrant a detailed study. Preliminary hydraulic evaluations indicated that control of the major (rarer) flood flows was not effective in output or level of need satisfaction; that the number of acres affected, either in terms of depth or duration of flooding, did not significantly differ per increment of flood decapitation studied. Therefore, the damage evaluation did not consider the total 317,000 acres in the flood plains. Instead, the prototype studies were confined to that portion of the flood plain that included about 156,900 acres inundated on the average of once every 50 years. Of this amount, approximately 42,700 acres are afforded some degree of flood damage reduction from reservoirs, either constructed or under construction. Included in the latter category are 37,300 acres on the main stem of the Big Muddy River below the Corps' Rend Lake Reservoir; 5,200 acres on the lower Crab Orchard Creek, downstream from the Crab Orchard Reservoir and operated by the U. S. Fish and Wildlife Service; and 200 acres on Kinkaid Creek below the Kinkaid Reservoir now under construction on a cooperative basis by the State of Illinois and the U. S. Forest Service. The remaining 114,200 acres, located mostly in the tributary watersheds, were studied to determine what measures might be provided to alleviate flood damage losses. Flooding on the tributaries occurs on an average of once every year, frequently resulting in moderate-to-severe damages to the agricultural acreage. The flood problems are further intensified by excessive periods of inundation and the frequency of minor floods occurring during the growing season. Damage to agricultural acreage in the bottom lands consists of destruction of crops, reduced crop yields, lower crop quality, and increased costs of production. Other losses include damages to roads, farm improvements, bridges, and some urban property. Most urban properties are located at higher elevations, and thus are subject to less frequent flooding. Current flood damage to the developments in the flood plain are estimated to be $1,466,000 annually. A breakdown of the present land use and estimates of damage sustained on that portion of the flood plain studied is shown in TABLE 5. While economic projections presented in APPENDIX L

TABLE M-5

FLOOD PLAIN LAND USE AND DAMAGES

Damage area	Acreage: Cropland, pasture and idle land	Acreage: Forest & misc.	Acreage: Total	Estimated average ann. damage
No. 1 & 9 Big Muddy (1)	14,100	23,200(2)	37,300	$ 174,100(3)
No. 2 Cedar Creek	400	1,000	1,400	8,500
No. 3 Kinkaid Creek	100	100	200	3,400
No. 4 Lower Beaucoup	9,300	5,100	14,400	26,400
No. 5 Galum Creek	4,400	3,700	8,100	93,500
No. 6 Upper Beaucoup	6,300	6,800	13,100	169,000
No. 7a. Upper Crab Orchard	3,500	3,800(4)	7,300	60,600(5)
No. 7b. Lower Crab Orchard	2,500	2,700	5,200	27,400
No. 8 Little Muddy	11,200	15,400	26,600	190,500
No. 10 Hurricane Creek	400	400	800	4,600
No. 11 Lake and Pond	1,500	1,100	2,600	18,800
No. 12 Middle Fork	10,200	10,500(6)	20,700	228,000(7)
No. 13 Gun Creek	800	100	900	28,600
No. 14 Upper Big Muddy	7,000	3,500	10,500	253,800
No. 15 Casey Fork	6,400	1,400	7,800	178,600
TOTALS	78,100	78,800	156,900	$1,465,800

(1) Big Muddy River flood plain downstream Rend Lake Dam and includes estimated average annual damage.
(2) Includes approximately 70 acres of urban area.
(3) Includes some $27,300 urban damage to Murphysboro, Blairsville, Hurst, Herrin, and Royalton.
(4) Includes approximately 20 acres of urban area.
(5) Includes some $15,400 urban damage to Marion.
(6) Includes approximately 10 acres of urban area.
(7) Includes some $700 urban damage to West Frankfort.

forecasted a decline in both farm population and related employment, an accruing increase in real income per capita is to be expected. This increase is predicated on an expected transition to larger farming units and greater investments per farm business, both required to attain the increased production necessary to counteract the cost-price squeeze. However, the forecasted increase in real income is a statistical result that does not truly reflect the need to enhance the economic efficiency or the competitive economic standing of the individual farm family. The farmer's real income, the retained profit margin and the relative income standing of the individual farmer per unit output of production has declined to the point where various types of water resource developments are required to help increase his production efficiency. This, in turn, would stabilize the industry and retain a labor component that otherwise, through outmigration, might become an underemployed or underutilized resource in another labor market. Furthermore, the need for minimizing the more frequent losses is necessary if the basin's relative production role in the regional and national food and fiber markets is to be maintained. A more detailed presentation may be found in APPENDIX F.

8. DRAINAGE

This basin has been identified as the most underdeveloped area in the State of Illinois with respect to drainage improvements. There are approximately 661,000 acres of agricultural wet land in the basin. Of this amount approximately 294,000 acres, both in the bottomlands and areas adjacent to the flood plain, were identified as warranting drainage improvement. A breakdown of these acreages by watershed is presented in TABLE 6. Contributing to these conditions are such factors as type of soil, the lack of sufficient topographic relief, and insufficient channel capacity. Generally, the Big Muddy River and most of the principal tributaries have neither the capacity nor the slope necessary to provide adequate outlets and permit installation of on-farm drainage systems. Poor drainage produces high water tables, prohibits development of the crop and pasture lands, restricts the choice of crop distribution and rotation, delays optimum planting, and increases production costs because of frequent replanting and delayed harvest. As a consequence, yields and economic returns from present crop lands are substantially below what could be obtained if adequate drainage were provided. Some form of channel improvement or rehabilitation is needed before the wet agricultural areas can be brought into more effective production. Additional information is presented in APPENDICES F AND K.

TABLE M-6

MAXIMUM NEEDS FOR DRAINAGE IMPROVEMENT

Watershed	Flood plain (acres)	Nonflood plain (acres)
No. 1 Lower Big Muddy	----	1,970 1/ 2/
No. 2 Cedar Creek	1,390	2,710
No. 4 Lower Beaucoup	1,930	12,990
No. 5 Galum Creek	8,040	7,010
No. 6 Upper Beaucoup	13,160	15,060
No. 7 Crab Orchard	7,260	24,190
No. 8 Little Muddy	26,590	20,690
No. 9 Central Big Muddy	----	36,480 1/
No. 10 Hurricane Creek	860	4,120
No. 11 Lake and Pond Creeks	2,530	12,280
No. 12 Middle Fork	20,670	23,880
No. 13 Gun Creek	960	6,710
No. 14 Upper Big Muddy	10,550	11,070
No. 15 Casey Fork Creek	7,810	13,080
TOTAL	101,750 3/	192,240 4/

1/ Includes flood plain

2/ Adjusted to correspond with Conservation Needs Inventory.

3/ Includes 46,040 acres of forest which will not require drainage in its present use.

4/ Includes 87,360 acres of forest which will not require drainage in its present use.

9. LAND TREATMENT MEASURES

a. Agricultural lands. Land treatment measures are needed to control and minimize the erosion and sediment damage presently occurring on lands that have potential for greater agricultural production. Failure to undertake proper land treatment measures has been one factor that prevented local farmers from attaining full economic competitiveness. Two types of erosion are found in the basin; namely, sheet erosion and channel erosion, including gullying. Both are active in varying degrees throughout the basin, with the rate and type being dependent upon local land use, topographic conditions, and intensity of rainfall. Sheet erosion removes a relatively uniform depth of soil without the formation of channels as gullies. Channel erosion removes soils along the natural watercourses. Sheet erosion is the predominant type, affecting some 586,100 acres, while gully erosion affects only some 16,100 acres. Of the total, approximately 303,000 acres require some immediate and corrective action. Stream bank erosion is comparatively minor, since stream gradients and corresponding velocities are low. Erosion damage within the flood plains is not extensive, with slightly less than 6,000 acres affected. The eroded soil is eventually induced by runoff into the streams where, as suspended sediment, it causes a highly turbid condition and a major pollution problem. Subsequently, eventual deposition of this sediment, which is frequently lacking in organic matter, becomes a source of concern since restoration is often costly. It is estimated that over 2,900 acres have been damaged by overbank deposition. Flood plain sediment deposition also creates natural levees along the stream banks, disrupting the natural drainage and producing swamping. Damage occurring as a result of swamping is considered very severe, with almost 20,400 acres affected. Swamping has resulted in a low-intensity use of the land in some areas and abandonment in other areas. In addition, sediment deposition in municipal impoundments is a problem which has resulted in considerable expenses being incurred to maintain storage capacity. See APPENDIX K for more detailed information.

b. Strip-mine area. Coal production in many parts of the basin has involved strip-mining operations. This form of production has stripped away the over-burden above the coal seams and left extensive amounts of overturned material exposed to the elements of nature. This material contains enough sulfides, iron, and sterile soil to create pollution problems both in the streams and on the land. The natural runoff flowing over the exposed material contaminates the basin by inducing acid drainage into the streams. At the same time, the runoff contributes a heavy sediment load to the stream from erosion of the overturned soil. These areas also deter growth of plant life and render the mine lands unattractive, creating an environmental as well as an economic problem. Unless the area is restored after mining operations are completed, the land is no longer productive and its value is decreased to the point that it becomes a liability rather than a contributing

source of tax revenue to the county. As man becomes more concerned with his environment, increased attention is being given to the restoration of these strip-mine areas. The Greater Egypt Regional Planning and Development Commission regards these areas as a land resource requiring extensive rehabilitation in order to improve their value to the basin. In some cases, mining companies have done very little towards reclaiming the stripped-over lands. In other cases, companies have shown initiative and foresight in actively renovating these lands well in excess of the minimum required by State law. However, many areas throughout the basin still remain an economic and aesthetic blight and need some form of rehabilitation.

10. STREAM QUALITY

Waste assimilation is one of the most important stream uses in the basin, but it is one for which most streams are least suited, due to the poor quality of surface runoff and the normally low flows. To determine the need for stream quality improvement, emphasis was placed on the major load points where the greatest flow supplementation for waste assimilation would be required. Estimates of future untreated waste loads were based on projections of population and economic activity. Since all significant oxygen-consuming industrial waste loads presently are discharged into municipal treatment plants, it was assumed that this practice would continue, and a minimum of secondary biological treatment afforded the effluent. Secondary treatment was assumed to provide 85 percent reduction in 5-day BOD and tertiary treatment 95 percent. However, to allow for the waste carried by urban storm drainage, these were reduced to 80 percent and 90 percent, respectively. Since percent removal is not a satisfactory criteria of adequate treatment for strong wastes, a maximum waste concentration of 35 mg/l 5-day BOD was assumed for secondary treatment and 20 mg/l for tertiary treatment. To identify possible flow regulation requirements for controlling stream quality a sampling program was made in various reaches of major streams to supplement available data. Subsequently, routings were made, utilizing information from the sampling program and considering such factors as: projected waste loads, oxygen demands for waste assimilation, and the low-flow characteristics of the hydraulic regimen. To ascertain the need for improvement, the projected stream quality parameters were compared with those required to sustain fish and aquatic life, the State-identified stream use. These latter requirements imply maintenance of 5 milligrams per liter of dissolved oxygen (mg/l DO). Where a standard of 5 mg/l DO could not be maintained, further routings were made to establish the nearest stream reach in which adequate DO levels could be sustained consistent with the increased drainage area/yield capability. These routings showed six stream reaches where low-flow supplementation could be provided to help assimilate the waste discharged from the key load points. The six load points are the communities of Pinckneyville, Du Quoin, Mt. Vernon, West Frankfort, Marion, and Carbondale. In addition, the Lake and Pond Creek Watershed was identified as having a special

pollution problem due to its acid mine waste. Since past experience has proven that low-flow augmentation is not a practical nor economical solution, remedial measures other than development of specific water-related resources are needed. These will have to be provided on a cooperative basis by the local industries, the State, and local interests. The details of this investigation are discussed in APPENDIX E.

11. GENERAL RECREATION

Evaluation of the outdoor water-related recreational demand utilized the populations of the five-county core area and selected SMSA's in both the Upper Mississippi River and the adjoining Ohio River Basins. The analysis recognized southern Illinois and the Big Muddy Basin in particular as a potential resource area for accommodating some of an external unmet need, primarily from upstate Illinois. Use of this expanded demand zone recognized the new travel pattern that the three interstate highways currently under construction will create in traversing the basin. When completed, they will open up the area to new population centers. These three highways are: Interstate Highway 57, connecting Chicago to New Orleans via Memphis; Interstate Highway 64, connecting St. Louis to the Virginia-Atlantic coastal region via Louisville and Charleston; and Interstate Highway 24 interconnecting Interstate Highway 57 in the southeast portion of the basin to the Florida area via Nashville. Factors considered in the analysis were: the time-distance-travel relationship of the population residing within the basin's zone of influence; the impact that three interstate highways will have in establishing the area as a focal point for outside origin-destination travel; length of recreational season for both the demand and service areas; and the present and potential land use in both the Big Muddy Basin and the recreation market areas. In computing the recreational demands, per capita participation rates for selected activities were applied to portions of the population located within the zone of influence. These then were converted to recreation days, using a factor of 2.5 activity occasions per recreation day. To this base, a portion of the vacation travel originating outside the zone of influence was added. This latter segment represented an impact creditable to those people whose origin-destination travel would be directed toward seeking partial or total satisfaction within the basin. Demand figures then were computed and compared with the estimated (time-phased) usage potential of existing and planned resource developments. The results indicated a net need (demand less supply) of some 2,000,000 recreational days by 1980; 5,200,000 by the year 2000; and 8,400,000 by the year 2020. In addition, the necessary water and land acreage needed to sustain the projected recreational deficiency was established. The water acreage required ranged from a base of 9,000 acres at 1980

to 19,000 by the year 2000 and 26,000 by the year 2020. Land acreage varied from 6,000 by 1980 to 12,500 and 17,000 for the years 2000 and 2020, respectively. All of these needs are in excess of the potential to be supplied by Rend Lake, Kinkaid Lake, Crab Orchard complex, and other water-resource developments, either completed or under construction. See Part 2, APPENDIX H for a more detailed presentation.

12. FISH AND WILDLIFE ASPECTS

An inventory of existing water and land resources indicated that the opportunities for both fishing and hunting within the basin's zone of influence more than adequately meets the projected needs for the study period. The evaluation of fishing opportunities, however, was primarily confined to a reservoir-related type of fishing pursuit. The State of Illinois and the Bureau of Sport Fisheries and Wildlife have indicated that there is a definite need to improve the qualitative aspects of the area's stream fishery. Steps must be taken to offset the adverse effects of pollution by reducing stream turbidity and acid content and increasing the stream flow and oxygen content. Once this is accomplished, the latent demand for stream fishing opportunities will make itself felt. Furthermore, continued expansion in urban, agricultural, and industrial land uses is expected to reduce the habitat available to sustain the diversified wildlife, particularly those species dependent upon river bottoms and adjacent lands. Consequently, there will be a need to set aside enough land, not only to maintain a proper habitat in blocks sufficiently large for good management, but to insure continued and improved access to those people desiring to hunt in the river bottoms. The basis for these conclusions is presented in APPENDIX I.

13. SOCIO-ECONOMIC REDEVELOPMENT

The basin's economic structure has for the first time stabilized, but at a level considerably below that of the nation's. Prior to the mid-1960's, the process of achieving a form of stabilization occurred through large scale out-migration. Subsequently, Federal and State investments have generated a higher but still depressed level of economic stability. If parity with the nation is to be achieved, additional programs are required to enlarge the economic base. At the same time, controls should be implemented to achieve an intermix of investments that strive toward a more equitable distribution of real income, employment, and population. No heavy industrial developments are projected for the study period based upon the area's share of the Upper Mississippi Region's growth pattern. Consequently, as indicated in APPENDIX L, there is a specific need to expand service-related and light manufacturing industries, thereby increasing employment and income. This requires an investment environment conducive to attract capital, people, and a willingness to upgrade the labor force. In order

to attain this economic goal, it was recognized that still greater reliance must be placed on water resource developments as a major catalyst for any subsequent socio-economic growth. Within this framework, it was then recognized that the investment process initiated by construction of Rend Lake must be continued, and that a specific attempt should be made to strengthen the recreation and tourism base previously established by Federal and State investment. It was felt that this latter industry would be most conducive in achieving a measureable degree of short-range success. In the report, "Water for Illinois - A Plan for Action," the State of Illinois indicated a major deficiency in available outdoor recreational opportunities. Illinois was cited as having the lowest ratio in the nation of total state park acreage to its population, having 5.6 percent of the nation's population, but only 0.05 percent of the country's recreational land. Consequently, existing facilities are overburdened and over half of Illinois's residents vacation out-of-state with a resulting loss to the State's economy of more than one-half billion dollars per year. The State, in cooperation with the Economic Development Administration, U. S. Department of Commerce, funded a study to analyze the economic potential of tourism and recreation in southern Illinois. The report included recommendations for expanding tourism and recreation in this area, identified the type and magnitude or benefits that could result, and discussed how to organize and finance the expansion. As part of the investigation, the report identified the main centers of competition in attracting tourists and in maintaining a recreational industry. Existing competitive areas included the Lake of the Ozarks in Missouri, the Kentucky Lake area, and many small natural lakes in the Wisconsin-Michigan area. Furthermore, two other areas were identified where future development seems readily assured through State and Federal participation: Wabash River Basin in southern Indiana and the Meramec River Basin in the southeast-central part of Missouri. Thus, it was concluded that the recreational development in southern Illinois must be extensive if a viable and competitive tourist industry is to be established. Hence, the report recommended that 48,000 impounded water surface acres be provided as an initial base for the required development of tourism and recreational facilities in southern Illinois. The State, through its participation in this study and subsequent actions, has indicated that the development of southern Illinois as a regional recreational center would alleviate the State's recreational deficiency and improve the area's economic base.

14. PRESERVATION OF ENVIRONMENT

Typical of many areas, planning agencies, private organizations, and local citizens have expressed concern over the causal effects of man's intrusion into his surrounding natural environment. This awareness has been demonstrated by proposals to prevent the potential loss of resources that comprise the area's culture and history. The objective has been to set aside certain land and water acreage as a balance to the expanding resource use resulting from population and economic growth. Involved is the basic consideration of preserving areas having biological, environmental, aesthetic, and historical significance which are so important to man's social well-being. As part of its plan for future action, the State has recommended an accelerated program of extensive public land acquisition to meet future open-space needs with the qualification that about 75 percent should be associated with existing or potential public water surface, and that major parkway systems and recreational corridors also should be developed for public use. The report stresses the advantage of combining the two resources, land and water, to complement each other and, under a planned development, greatly increase the value of both for recreational usage. A similar concept was expressed in the land-use plan of the Greater Egypt Regional Planning and Development Commission which called for establishment of specific recreational-environmental river corridors. These lands and reaches of streams would be maintained for public use and would help preserve a balance in the socio-economic development of the basin. Some of the same acreages are in the State's Plan for Action as a parkway corridor connecting the Shawnee National Forest in the southern part of this basin with the adjoining Kaskaskia River Basin to the north and its Reservoir complex of Carlyle and Shelbyville. As part of this study, investigations were made to identify and locate the basin's historical and archaeological artifacts. A field study verified the existence of archaeological remains that are historically associated with Indian tribes which once lived in this part of the country. Three types of sites were found: open village or camp sites; habitation sites such as rock shelters and cave sites; and burial sites. Existence of a fourth type, a temple town or Indian mound site representing a more advanced form of population concentration, is possible, but none have been found to date. Other known historical sites that are of potential public interest are stone forts and block houses, originally built by the early settlers in this part of the State. Since, in many cases, the archaeological sites were river-oriented, preservation or reconstruction of these historical and archaeological remnants would promote the recreational development of the basin. The results of the archaeological investigation are presented in Part 1, APPENDIX H.

15. OTHER NEEDS

Consideration also was given to the possible needs for water supply, navigation, irrigation, hydropower and steam power generation. In all cases, it was found that there were either local plans and commitments to meet the projected future demands or that the increments of needs were such that any development required could not be economically justified at this time.

a. Water supply. The demands for future municipal and industrial water supplies were evaluated, based on the projected increase in population, standard of living, and industrial and commercial development. It was assumed, as was indicated in APPENDIX L, that basin industry would be dominated by light manufacturing and commercial industries of the general type now present and which are not heavy water users. Because of the limited ground water, and except for several self-supplied industrial developments, most of the industrial water is obtained from the municipal water supply systems. Therefore, it was assumed that, in the future, industries will continue to obtain their water from these municipal systems. To identify the predominant demand centers, estimates of future municipal and industrial water usage for each of the five core counties were disaggregated to obtain estimates of use for the individual municipalities. Subsequently, an inventory of existing impoundments and firm commitments for providing future water supplies was undertaken and compared to the demand. Construction of Rend Lake Dam and Reservoir, together with an intercity distribution pipeline, will assure a dependable source of water supply in excess of the year 2020 projected needs for those areas and individual communities located in the middle and northeastern part of the basin. As a result, the only areas of possible water shortages involved those communities outside the intercity pipeline distribution system, particularly the towns of Marion, Murphysboro, and Carbondale. Existing storage for all other remaining communities is sufficient to meet the projected requirements, excluding any consideration of extended drought periods. The town of Marion is planning to enlarge its present water supply reservoir, providing sufficient storage to carry it through the study period. The State of Illinois is including municipal and industrial water supply storage in its Kinkaid Lake Reservoir sufficient to meet the future needs for the town of Murphysboro. This left Carbondale as the only community that could have a definite water supply problem. Preliminary investigations subsequently identified that there were four alternatives, any one of which would be responsive to satisfying this future need. Presently, the community of Carbondale is studying the feasibility of constructing its own project for water supply or participating with the Soil Conservation Service in sponsoring construction of two multi-purpose reservoirs in the Cedar Creek Watershed. The work plan for the latter alternative has been completed and approved by the Governor of Illinois for implementation under Public Law 566. In addition, water could be obtained from Rend Lake and the downstream releases stored in off-channel reservoirs. In this case, a suitable contractural agreement involving usage and

delivery rates of the projected excess in water supply would be required. Finally, there is sufficient storage in the State's Kinkaid Lake that could be made available by pipeline transfer. The feasibility of this proposal, however, would be dependent primarily upon the effects that the increased drawdown would have on the project's recreational potential. Since any of these alternatives would be capable of meeting Carbondale's requirements, it was apparent that there was no need for additional studies. Consequently, it was concluded that provision of future water supplies would not be considered in any action program that was formulated for the basin unless the State was specifically interested in purchasing additional storage. The State, by letter, indicated that the basin's water supply storage, both existing and under development, appeared adequate to meet all foreseeable needs and that there was no interest on the part of the State to invest in additional supplies at this time. A detailed evaluation of this phase of the basin's study is presented in APPENDIX E.

b. Navigation. The potential and economic feasibility of improving the Big Muddy River and Beaucoup Creek for modern barge transportation was investigated. Adequate reserves of good quality coal in the basin are available for existing and prospective market areas. However, the required improvements were not economically justified. Thus, the advisability of improving the basin's waterways was deferred until economic conditions warrant. APPENDIX G contains a further discussion of navigation.

c. Irrigation. A survey of acreage presently in agricultural production served as the basis for estimating the extent of any future demands. The survey indicated that irrigation is practically non-existent. As stated in APPENDIX K, no extensive irrigation practices are anticipated to be undertaken on an organized basis in this general part of the Upper Mississippi River Basin until about the year 2000. In the Big Muddy Basin, there are three basic variables in optimizing agricultural production: hybrid seed, fertilizer, and controlled moisture content of the soil. It is believed that advances in technology for the first two variables will account for all of the production increases up to the year 2000. Thereafter, irrigation will be undertaken on an organized basis to increase the yields and quality of the crop.

d. Power generation. The electric load of the basin and the electric systems serving the area are included in that part of the Federal Power Commission's Power Supply Area (PSA) 40 located within the Upper Mississippi River Basin. The Big Muddy is presently served by five electric utility systems, all of which have their plants located outside the study area. As part of the economic resource - demand evaluation, consideration was given to the possibility of electric power being generated in steam plants located at the mineral source of its fuel (coal), and/or hydropower generation. No hydropower developments exist within the area. Natural conditions, such as stream flow and topographical static head, preclude development of hydroelectric power in amounts sufficient to be economically competitive in the present and foreseeable market.

For the purposes of this study, the electric power requirements and supply characteristics within PSA 40 were considered to be indicative of the power situation of the basin. Based on a study of this power area, the basin's electrical power requirements are expected to grow at a decreasing rate during the period 1980 to 2020. In light of the past trends of supplying the basin's electrical requirements by imports, the transmission system serving the area, and the reported plans of the systems now serving the basin to increase their generating capacity, it is anticipated that the future electrical energy requirements will continue to be met by generation located outside the basin. Therefore, it was concluded that there would be no additional input-demand (consumption) on the basin's mineral resources and water resources (water supply and stream quality) over and above that already identified.

SECTION III - PLANNING GOALS AND OBJECTIVES

16. PLANNING CONCEPTS

The basic purpose of this study is to develop a workable, but flexible, plan of improvement that will provide for the best use, or combination of uses, of the basin's resources in meeting its short- and long-range needs. To successfully achieve this purpose involved alternative considerations of various types of resource development and management concepts, all weighed within the responsive framework of regional and national objectives and constraints and local social well-being. This meant providing a regimen of resource management which maintains a balanced relationship between man and his natural or created environment. Consideration was given to all purposes for which a plan of improvement might serve. The formulation process was a two-step procedure: first, to identify a scale of development based on an economic evaluation considering only tangible benefits and project costs expressed in comparable terms; and second, to modify that base line plan to meet those intangible needs that warrant consideration but cannot be measured in economic terms. This analytical procedure established a framework for making reasoned choices between potential uses of the basin's land and water resources, and insured inclusion of the social-environmental requirements in the decision-making process.

17. DEVELOPMENT GUIDELINES

In order to guide resource planning and development, three basic guidelines were established:

a. To provide the necessary land and water development to sustain the projected socio-economic growth;

b. To encourage the preservation and enhancement of the area's natural environment; and,

c. To provide an effective plan for staged development and efficient usage of all resources, i.e., land, water, and capital.

Towards this end, the land-use plan prepared by the Greater Egypt Regional Planning and Development Commission was used as the basic development guideline for two reasons: first, it had similar objectives and proposals regarding the same types of needs established by this basin study; and second, the plan which was formally adopted in 1965, by the then four participating counties, was considered to be an

expression and commitment of the local residents. The Commission's proposals were time-phased over a period extending from 1985 to 2025 and served as the basis for achieving maximum development by control of the area's main socio-economic inputs. The local plan was based on a framework concept of concentrating future resource development into the five major areas which show maximal growth potential: Mt. Vernon-Rend Lake area; Benton-West Frankfort area; Marion-Herrin area; Murphysboro-Carbondale area; and the Du Quoin-Pinckneyville area. This principle of concentration offered the greatest opportunity for successful development and, at the same time, insured that the economic return would be distributed throughout the basin. Furthermore, the possibility of specialization within each of the growth centers then could be achieved in a controlled, but complementary, framework that would eliminate much duplication of function. This procedure recognized that while each growth area has its own sphere of the urban/industrial/commercial development, each is still tied to the others through economic activity, highway patterns and common problems. The area bounded by the five growth centers tends to place the urban population and economic activities in the center of an outlying environmental (open space) area of agricultural and recreational activities. The land-use plan envisions a phased growth, controlled so that urban expansion would be concentrated in those areas presently semi-urban; and future semi-urban areas would be established on acreage where development is now scattered. This control of land resource use specifically minimizes the land area that would be developed to meet the urban needs and maximizes the amount available for open space, including agriculture development. The plan underlines the important factor that residential development should occur in areas adjacent to the existing larger communities, and recommends proposals for the use of waste lands and establishment of recreational and green belt areas.

18. PLANNING GUIDELINES

To determine the extent to which planning concepts could be implemented, various types of investment programs capable of meeting the basin needs were analyzed relative to their output and socio-economic contributions. Specific objectives were established for each identified need so that the formulation of individual projects would be effective in attaining the desired performance standard. These objectives are summarized in the following paragraphs:

a. Land usage objective.

(1) That productive output of the proposed improvements be in consonance with the intent contained in the land-use plan prepared by the Greater Egypt Regional Planning and Development Commission.

(2) That action programs for land treatment measures and drainage improvements be first evaluated in strictly economic terms, identifying the worth of increased production efficiency.

(3) That subsequent to final economic evaluation, improvements be modified where and however needed in order to maintain a proper socio-environmental balance.

b. Flood control objectives.

(1) That control of flood flows be optimized in terms of hydraulic and economic efficiency and that the degree of protection provided be uniform within each watershed.

(2) That the effects of watershed land treatment measures and drainage improvements, as they affect the hydrologic and economic aspects of the study area, be considered.

(3) That the economic evaluation be based on the land-use patterns and yield projections furnished by the Economic Research Service, Department of Agriculture, as reflective of the forecasted regional agricultural development for the Upper Mississippi River Basin.

(4) That major emphasis be accorded control of flood flows in recognition of a dual-service role: enhancement of the agricultural productive efficiency and stabilization of farming's relative industrial standing. Achievement of the resultant agricultural enhancement would provide additional stimulus to the redevelopment of the basin's economic structure.

c. Recreational objectives.

(1) That the optimum recreational potential of each project be developed, recognizing the competitive effects of other existing and proposed water and land projects within the zone of influence.

(2) That sufficient reservoir design criteria be established to assure comparability of recreational potential; and that where multiple usage of a reservoir's storage is contemplated, the effects of drawdown in the joint-use pool be analyzed to identify optimum potential of that project.

(3) That major emphasis be accorded development of water surface acres and facilities for general recreation to satisfy the unmet recreational needs projected for a zone of influence, including portions of upstate Illinois and serve as a base for the subregional development of a total tourism and recreational industry, all in accordance with the State's long-range goals for southern Illinois.

(4) That non-Federal interests be encouraged to participate in the development of the short- and long-term recreational programs, and that they be responsible for operation and maintenance of the individual project's recreational areas and facilities.

(5) That, regardless of the projected surplus of fish and wildlife opportunities to needs, the development of each reservoir site provide for the propagation of fish and wildlife so that the needs of future generations can be met. Consideration also should be given the need for the qualitative improvement of stream fishery and related opportunities.

(6) That project formulation and comparative analysis be based within the framework of optimum development with time phasing of development in consonance with the need projections.

(7) That projects economically justified and included in the final plan of improvement be authorized with the initial level of development specified in recognition of the desires of local interests and the inability to schedule and commit long-range financial participation. While the scope of initial recreational facilities for the various projects will differ, future development can be provided incrementally under Public Law 89-72. In all cases, the land acreage required for optimum development should be included in the initial acquisition.

d. Stream quality objectives.

(1) That provisions for supplemental storage to maintain stream quality be considered, not only to improve or maintain a desired quality standard, but also to maintain a minimum base flow where conditions so warrant.

(2) That storage for low-flow augmentation be provided, where feasible, in areas where the need has been determined and where provisions of such storage is in accordance with the desires of the State.

(3) That the amount of storage initially allocated for low-flow augmentation be based on the next 10 to 15-year needs; and that the additional storage increments required for the long-range needs be provided as part of a restricted dual-use pool permitting future reallocation, should the need for such storage be obviated by a more economical and higher degree of treatment.

e. Environmental management objectives.

(1) That while every effort should be made to include preservation of historical and archaeological artifacts into the proposals for environmental management, the overriding objective will be to insure a proper balance in man's total economic and social environment.

(2) That stream developments be considered in consonance with the State's and local counties' proposals for establishing river recreational-environmental corridors.

(3) That proposals should include both water- and land-related developments to obtain maximum potential.

(4) That developments be correlated with those known land and water facilities that have both national and regional significance.

(5) That as part of the environmental control, attention be given to improving both the quality and management of the area's wildlife habitat and stream fishery ecology.

SECTION IV - SOLUTIONS CONSIDERED

19. GENERAL

Subsequent to identifying the basin needs and establishing the planning objectives, attention was directed to the types of alternative means that could be considered in formulating a meaningful plan of development. The importance of this evaluation was threefold: first, it objectively identified all possible methods of accomplishing a required service; second, it established a framework for selective screening of those means in terms of efficiency and effectiveness (degree of need satisfaction); and third, it identified on a comparative basis the type and amount of resources required to meet a need. This latter analysis also established a framework for a reasoned choice between developments based on the use of resources involved, and permitted a controlled commitment of resources that effectively establish the desired economic and socio-environmental structure of the basin. The range of alternatives considered and the rationale involved in acceptance or rejection of these types of developments are discussed in the following paragraphs.

20. MANAGEMENT OF FLOOD PLAIN

a. General. The land-use plan prepared by the counties, and adopted by this study, requires that the flood plains be developed for both agricultural and/or recreational usage. Thus, in accordance with the planning concepts outlined in Paragraph 16, the bottom lands were first analyzed to determine the economic worth of reducing the flood damages and draining the wet lands. This would provide a base plan which could then be modified for those intangible social needs that cannot be measured in economic terms. Inherent in any action program for enhancing the economic well-being and competitive economic standing of the individual farm family is a basic need to improve the productive efficiency. To do this means that those flood plain acres in need of drainage improvements first must be provided some degree of flood protection before the farmer can institute the improved agronomic practices required to enhance his crop pattern and yield output. This, then, involved providing dual-service improvements for both flood control and drainage, and consideration of both structural and non-structural measures.

b. Structural measures. The alternative possibilities for control of the water regimen included reservoirs, channel improvements, levees, and combinations thereof. Preliminary hydraulic analysis had indicated that while reservoir control of the more frequent floods was feasible, retention of the major flood flows (rare floods) was neither feasible nor effective in output. This conclusion was developed

from two preliminary hydraulic evaluations. The first study considered only flood flow decapitation by reservoirs located on the main stem of the tributaries with various increments of storage ranging from 10 to 100-year frequency capacities. The results indicated that the proposed projects, or group of projects, were not economically feasible, nor was the number of acres protected in terms of depth and duration of flooding effectively reduced per increment of flood control studied. The second study involved installation of channel improvement only for equivalent degrees of flood control. These channel improvements required extensive excavation to achieve a comparable gradient sufficient to control and contain the runoff volume of the more frequent floods. Furthermore, preliminary hydraulic routings reflecting the changes in times of concentration of peak flows from the tributary watersheds caused by the channel improvements, resulted in adverse effects in the area-stage-elevation relationship on the main stem of the Big Muddy River. This would negate existing and potential land use made feasible by the flood control storage included in the authorized Rend Lake Reservoir Project. Consequently, channel improvements only were rejected on both a cost and hydraulic-efficiency-basis when compared to detention reservoirs for providing equivalent flood decapatition per reach of stream. Local levee projects also were considered, but rejected on the basis of an efficiency comparison-unit cost per acre benefitted. Design would require extensive levee length and remedial measures to control interior flooding (diversion of interior water courses) before any significant degree of effectiveness could be obtained. Therefore, it was concluded that to achieve the desired productive enhancement of the bottom lands and adjacent acreages, a system of headwater reservoirs located off the main stem of the tributary watersheds, supplemented by channel improvements, would be the more hydraulically effective and economically efficient method of structural measures.

c. Non-structural measures. As part of the evaluation for reducing flood damages, flood plain zoning was considered. It was recognized that this non-structural alternative is not a water control or flood height reduction measure, but rather a means of controlling or regulating development in an area subject to floods. Flood plain zoning is a way of living with over-land flood situations and attempts to minimize losses by restricting the physical development and resulting damage within the flood plain area. It was also recognized that care must be exercised when suggesting flood plain zoning regulations in order to assure that those activities and pursuits which require waterside sites, or which enjoy a net economic advantage by locating in the flood-susceptible areas are not denied use of the flood plain area itself. The primary usefulness of this method is prevention of an unwarranted increase in flood damages and losses due to improper use of natural resource. In balance is the question of resource use and feasibility of providing an investment program to protect

the existing and projected development activities and productive output. Also pertinent is the concern regarding the appropriateness that the resource use and potential output contributes to the income and development needs of the area, region, and nation. Since planning for flood plain development is predicated on an open-space usage of both agricultural and recreational developments which normally have an economic advantage when located in flood prone areas, and because this type of development is in consonance with both the local and regional pattern of development and income contributions, zoning as a basic flood damage control alternative was rejected. However, flood plain zoning was retained as a potential supplement to an action program, if both flood control and drainage are justified. This would be an added control to insure proper resource usage in accordance with the selected pattern of development and the national objective of maximizing income efficiency. Other complementary programs should include the need for land treatment measures and proper land-use practices that encourage planting of suitable vegetative cover.

21. STREAM QUALITY

The alternative possibilities of improving stream quality included: reservoirs, advanced treatment, tertiary treatment, pipeline transfer of effluent within the basin, and restrictions on the stream and land use.

a. Reservoirs. Construction and operation of a reservoir with releases phased to supplement natural flows was found to be an acceptable alternative measure in maintaining the selected stream quality standards. Resource consumption by a reservoir would involve utilization of a replenishible (rainfall) resource and complement the commitment of financial resources for waste treatment required in the basin by individual communities. Furthermore, in terms of effectiveness of service, a reservoir would create a secondary input to the maximized usage of the basin's resource by establishing an enhanced (stream) flow which is necessary to the socio-environmental needs.

b. At-source treatment. Advanced treatment was selected as one alternative, with the basic criterion of quality service equivalent to that provided by supplemental or dilution flows. Hence, it was retained and used as an equivalent measure of output for maintenance of stream quality, but not stream flow quantity. Tertiary treatment was studied, but discarded when it was concluded that it was not the equivalent in terms of effectiveness (degree of need satisfaction) to either dilution flows or advanced treatment. Even with conventional tertiary treatment, some dilution flows or reduced amounts would be required to maintain the required standard of stream quality. The economic worth of this latter combination of tertiary treatment and dilution flows was found to be more costly than providing advanced treatment measures. Furthermore, to provide the equivalent service, tertiary treatment would require the use of an

additional resource, water, over and above the same two, mined and manufactured materials and financial investments, required by advanced treatment. Thus, it was concluded that of the two acceptable at-source forms of treatment, only advanced treatment with its governing criteria of optimum (cost) efficiency, effectiveness of output services, and minimal usage of resources, should be retained for further consideration.

c. Intra-basin pipeline transfer. Intra-basin pipeline transfer of municipal waste was studied in progressive steps, pumping waste effluents from the original discharge point to reaches of streams with greater drainage areas and increased natural flows. In all cases within the tributary watersheds, maintenance of stream quality at the new discharge point still required some, though reduced, supplementation of natural flows. The combined system of pipeline and reduced supplemental storage to dilute the pumped effluent proved to be more costly than providing the necessary supplemental flows by just a single-purpose reservoir. However, if the load point was close enough to those reaches of the main stem of the Big Muddy River which will be augmented by releases from the Rend Lake project, transfer by pipeline was found to be the least costly alternative to providing either supplementary flows by single-purpose reservoir or advanced treatment. In this case, the financial investment would be the only resource commitment involved as increment to those already authorized and under development.

d. Ground water. As an adjunct to the foregoing, use of ground water for supplementing stream flow was also considered. The U.S. Geological Survey, as part of its investigation for APPENDIX B, AVAILABILITY OF GROUND WATER, determined that the ground water yields from all areas in the Big Muddy Basin, except the Mississippi River flood plain, are inadequate for any use other than water supply for an individual or for small municipalities. Thus, the practicality of pumping ground water from well points only in the Mississippi River flood plain was investigated. However, the use of this resource was rejected based on design factors established for preliminary evaluation. The range of flows, pumping head (static and dynamic), and pipeline lengths resulted in cost factors for construction and annual operation that were too high to warrant further consideration.

e. Restrictive resource use. Early in the study, a water sampling program was undertaken to determine the existing qualitative aspects of the basin stream. Analysis indicated that stream pollution was induced from an intermix of sources, such as agriculture, mining, and municipal and industrial components. The impact and economic solutions that could be applied to agricultural-related pollutants other than erosion damage, are still subject to extensive research and development studies. At present, no known

suitable controls could be applied without adversely affecting the potential of the basin's total land-use plan and economic competitiveness and its contribution to the region's development. Mining, and its adverse effect on stream quality, cannot be overcome by zoning or restrictive use. Instead, there must be a concerted effort by that industry to control its operations and manufacturing processing. Adequate treatment and disposal control of its wastes and residues would alleviate a major portion of the problem caused by surface runoff inducing the mineral wastes into the streams. One of the main sources of pollution is the sewage discharged from major communities. Many of these municipalities are located on lateral tributaries with small drainage areas rather than on main waterways. Their wastes with the industrial effluents are discharged near the stream headwaters where the assimilative capacity of the natural flow is insufficient; hence, the stream quality has been degraded. Achievement of the land-use plan for urban and industrial concentration is too far advanced to alter without seriously affecting the socio-economic structure of the basin. Therefore, from both an efficiency and effectiveness standpoint, and from a viewpoint of resource commitment and utilization, the alternative of revised water use and land zoning was rejected as not being a practical nor socially acceptable method of control.

22. GENERAL RECREATION

a. General. In determining the various alternatives for outdoor recreation, the needs and planning objectives were restricted to water-oriented activities. Specifically excluded were consideration of land-related activities and stream-related development, since it was regarded as more appropriate that these needs be evaluated within the framework of environmental control and management. The alternatives studied were evaluated and compared only in physical terms, e.g., water surface acreage, plant facilities and the project associated lands, and the resultant economic effects on the basin's pattern of development. The evaluation was a two-step procedure: a comparative analysis of possible developments within the basin; and identifying the governing economic worth of developing recreational opportunities in this basin as compared to other service areas.

b. Basin developments. This evaluation basically consisted of determining the comparative worth of providing new water-based resource developments and/or extending the scale of those projects authorized, under construction, or completed. Specific facilities were not programmed for that part of the Shawnee National Forest located within the hydrologic boundaries of this basin. It was the opinion of the Study Committee that development of this particular resource should be planned and programmed on a scale commensurate with its potential of regional and national significance. Three existing reservoirs, Crab Orchard, Devil's Kitchen, and

Little Grassy are maintained by the U. S. Fish and Wildlife Service and operated as part of a multiple-use wildlife and waterfowl management area. Further expansion of the existing recreational facilities are not presently planned; instead, increased emphasis is being placed on the programs for wildlife conservation, and the joint management with Southern Illinois University of the area as an outdoor laboratory for biological studies, education, and research. This programmed objective was of enough national importance to preclude any significant modification for meeting an increased recreational or any other type of demand. The Corps' Rend Lake project, now under construction, did have some potential for assuming some increased recreational usage. Two alternatives were available: change in storage allocations; and/or provision of additional facilities by upgrading the priority of use for some project-associated lands. Only the first alternative was excluded, because the site's total storage capability has already been maximized. Modifying the plan of development for the Kinkaid Lake project was also reviewed. However, it was concluded that the plan of improvement as formulated was already heavily committed to meet future recreational needs, particularly by the U. S. Forest Service as part of Shawnee National Forest's long-range program; and any extensions were not warranted at this time. Finally, modification of the existing municipal water supply reservoirs was considered. With the construction of the Rend Lake intercity pipeline, these surface impoundments may not be needed and will be maintained only for stand-by emergency use. However, local planners have indicated that these reservoirs are being considered for use in conjunction with development of industrial parks and are considered as basic to the individual municipality's long-range growth pattern. Consequently, the recreational potentials of these impoundments were not reevaluated, but assigned only a usage creditable under existing conditions. Thus, it was concluded that only some increase in visitation potential of Rend Lake and the Crab Orchard complex was appropriate as an alternative, or supplement, to construction of new reservoirs.

c. Alternative worth. To establish the measure of comparable investment of water-related development in this basin, data from the adjoining Wabash River Basin were used. Since the demand evaluation had identified the Wabash as an area essentially serving a similar recreation market (population), the comparability was regarded as valid. Data extracted from interim reports on the Wabash Basin permitted estimates of basic reservoir construction costs expressed in unit-cost-per-water-surface-acre. The alternative worth was then computed as being equivalent to the sum of reservoir construction costs and the specific recreational facilities and land charges. While this value would be suitable for consideration in cost allocations, it should be realized that it did not reflect the additional level of input value to the local economy, namely tourism.

23. ECONOMIC REORIENTATION

There are no known alternatives to area redevelopment per se, other than a negative possibility of a do-nothing program permitting the basin area to stabilize at a depressed level by denying economic assistance to the area. The evaluation for this report has purposely ignored the concept of generating public works as a source of make-work employment; instead, it has concentrated on providing known and proven resource developments in a framework of assistance that would insure a continued socio-economic return by stabilizing existing industries and creating new industries. Inaction would essentially encourage a resumption in out-migration of both people and capital, and would be contrary to the national objective of maximum economic efficiency and achievement of human satisfaction. Moreover, it would not provide the products and services required if the basin is to sustain its projected share of the region's development. To assist in the governmental efforts of reorienting and enlarging the basin's economic structure, particular emphasis has been placed on the enhancement of the agricultural industry and the establishment of an adequate base for development of a tourism and recreational industry. Without the extensive development for agricultural enhancement, the industry, as it exists today, will continue its decline, fall short of its projected standing in the industrial make-up of the basin, and fail to meet its quota of the national food and fiber market. Development of the tourism and recreational industry in this part of Southern Illinois serves both a regional and State effort to maintain a socio-economic balance in a pattern of development. Projections indicate that unless a concentrated action program for recreational development be undertaken in this part of the State, there will be a further worsening of the region's deficiency in general recreational opportunities. This, in turn, will require a shift-distribution of regional and national needs that will not be easily met when considered from resource availability, capability, saturation, investment, or any other constraints.

24. ENVIRONMENTAL CONTROL

Planning for environmental control implies recognition that one of the basic concerns in any plan of improvement is preservation of the ecosystem. This requires that development of the land and water resources is accomplished in a way which will achieve a proper balance between man and his environment. The action programs then must be evaluated in terms of needs for: conservation of the ecological system and flora and fauna; preservation of the archaeological artifacts that comprise man's culture; and management of those resources that can enhance the aesthetics and living environment of the area. The types of improvements considered were thus restricted to those providing an enhanced environment and increased the recreational potential of both water and land resources; namely, recreational corridors or river parkways, selective open-space zoning and/or cultural easements, and reclamation of strip-mine areas, all in accordance with known State and local planning objectives.

25. SUMMARY

Only certain types of alternatives were considered reasonable and economically justified to thus warrant consideration in the plan formulation process. Included were reservoirs constructed as either single- or multiple-purpose projects for flood control, low-flow augmentation, and water-related outdoor recreational opportunities. In addition, watershed protection augmented by channel improvements is needed as part of a system providing for flood control and drainage needs. Other alternatives involved advanced treatment and pipeline transfer of effluent in lieu of providing supplemental flows for low-flow augmentation, and flood plain zoning as supplemental to an action program for agricultural enhancement. Single-purpose nonstructural developments included: stream-related corridors and reclamation of strip-mine areas, both needed for recreational land-related activities; preservation of archaeological and historical artifacts; improvement in wildlife habitat; and environmental considerations.

SECTION V - FORMULATION CONSTRAINTS

26. CRITERIA

In formulating a basin plan of improvement, special consideration was given to those projects, or groups of projects, that would not only meet a specific need, or group of needs, but readily contribute to the area's economic growth. As previously indicated, an economic evaluation first was undertaken based on tangible benefits and costs expressed in comparable terms. Subsequently, this baseline plan was then modified to meet known environmental needs; thus providing a balanced plan truly comprehensive and responsive to social satisfaction and economic efficiency. The evaluation involving tangible benefits was based on the principle that the selected project, or groups of projects, should be the most economical means of accomplishing their specific purposes. Thus, each development, or increment thereof, included as an integral part of the system, is developed to the scale that produces the maximum excess of benefits over costs. Where long-range water needs are foreseeable only in general terms and where alternative means for meeting these needs are not available, consideration also was given to including additional storage in reservoirs where it can be accomplished at a significant savings over the cost of subsequent enlargement. The procedure for determining the baseline plan of development involved three broad planning steps:

a. Define and locate both present and future water- and land-related resource needs;

b. Use of successive evaluations in terms of input and accruing benefits to provide the needed goods and services by alternative developments, assuring a balanced plan of water resource development consistent with the needs; and,

c. Analysis of each increment of development to insure maximization of net benefits while meeting the needs for multiplicity of demands.

27. FACTORS AFFECTING ANALYSIS

a. Time. The time of need was recognized as a major factor in establishing the plan of development required to meet the basin needs. A period of 50 years was selected for analysis of the economic trends and the determination of the type and magnitude of water and land needs that could be expected to develop. The requirement

for the first need increment (1980) was used to establish the nucleus of basin development. Once this base had been established, the long-term needs, as indicated by the requirements for the latter increments of time (2000 and 2020), were met whenever possible to achieve the best use of the resources employed. This planning procedure assured consideration of all factors in determining the scope of development and maximizes net benefits on the basis of factors measurable in quantitive economic terms.

b. Area. The geographic distribution of the problems associated with water resources was an influencing factor in the plan formulation. The need for flood control and stream quality augmentation for the major portion of the main stem, Big Muddy River, will be met by construction of the Rend Lake Dam and Reservoir. Therefore, the location and scale of development that would be considered in meeting the remainder of these two needs and the drainage needs required an individual-tributary watershed analysis. Planning for recreational development was treated as a basin-wide need, but concentrated in those areas in and around the major growth centers, as defined by the economic base study and Greater Egypt's land-use plan.

28. DESIGN AND PLANNING CONSIDERATIONS

To satisfy the present and future needs of the basin, each reservoir site was analyzed for total-site development. Reservoir storage was either maximized with regard to topography or optimized relative to incremental cost benefit analyses, which indicated that the extension in the scale of development would require expenditures in excess of benefits added. Based on this planning consideration, the following design parameters were established.

a. Flood control and drainage. Prototype reach analysis involving hydraulic and economic evaluations indicated that damage reductions would result primarily from a reduction in area flooded rather than from a reduction in depth of flooding. The analysis also indicated that maximum benefits would be obtained by a reduction of those flood flows which have a frequency of occurrence ranging from 1 to 3 years; furthermore, that any effective reduction in flood acreage would require a completely controlled water regimen. This would involve retention structures strategically located so as to control local flood runoff, rephase time of concentration, and reduce peak flows. Successive hydraulic screening eventually identified the optimum plan of improvement as one that would control a minimum of 25 percent of the watershed area and maintain a maximum control release rate of from 10 to 15 c.f.s. per square mile. The control release rates were established to reduce project outflows up to a 5-year frequency event for the major reservoirs and 25-year frequency event for the smaller structures. It was realized that channel improvements would be feasible only in those areas where

sufficient lands could be benefitted and on acreages that would be affected by reduction of floodwater damage. These acreages were subsequently modified (reduced) by deleting the tributary acreages affected by the 2-year frequency mainstem flood. The result was a total hydraulic system which reduces flood damages by controlling the more frequent flows and increasing channel capacity to provide for agricultural drainage.

b. Land treatment measures. Part of the total program for agricultural enhancement involves the need to minimize the erosion losses. Success in controlling the runoff rates and resultant erosion is directly dependent upon the type of soil and accomplishment of proper land use programs. Improvements in the quantity and quality of ground cover due to conserving cropping patterns and higher fertility levels tend to decrease runoff and minimize upland silt production. Proper land use and improved land treatment are the first increments in an effective flood damage reduction program and a comprehensive effort must be made to encourage proper agricultural practices and land treatment measures. Treatment will consist of such conservation practices as: contouring, terracing, grassed waterways, conservation cropping systems, minimum tillage, farm ponds, drainage field ditches, pasture planting, and timber stand improvement.

c. General recreation.

(1) Reservoir criteria. As part of the need evaluation, design criteria were established relating applicable reservoir visitation and optimum development to a range of water surface acreage. The design criteria recognized a variable relationship between water surface acreage and creditable visitation potential based on a reasonable saturation limit for peak recreation days. Within this framework, the cost of the facilities was then expressed in terms of unit development cost per user-day. The unit cost was kept sufficiently high to insure that the physical plant would be of sufficient quality to provide adequate service and diversified opportunities for the recreationist. To provide lands, both project-associated and single purpose, sufficient for installation of developments and use per type of activity, a 2 to 3 ratio of land to water acreage was used. A unit charge of $0.20 per user-day was selected as equivalent to the costs that would be incurred for operation, maintenance, and replacement of the recreational facilities.

(2) Factors for tourism development. The report which investigated the economic potential of developing tourism and recreation in Southern Illinois implied the need to establish individual impoundments, the sizes of which range from approximately 500 to 9,000 surface acres as an initial base for long-term development. Consequently, this study attempted to select those reservoirs for initial developments

that would provide joint-use pools within this range, since size is such a critical factor in attracting private investment capital to the area. Long-range planning for tourism and recreation will be predicated on Rend Lake being developed as the major center for public recreational opportunities. The recreational plan presently provides for extensive development of basic facilities and diversified recreational opportunities on project lands by the Federal and State governments. This would be supplemented by an in-depth protective zoning and development on lands surrounding the reservoir. To complement these basic recreational developments, several local entities are developing plans for construction of major luxury-type resorts and convention center facilities, all located on adjacent, non-project lands. Most significant are the plans of the Rend Lake Conservancy District which would provide controlled and zoned development of restaurants, nightclubs, motor inns, and a 27-hole championship golf course. In addition, the Rend Lake Junior College recently has been created and established as part of an extensive development center, contiguous to the project lands. Included in this complex will be high-rise buildings and shopping areas that will serve both the campus residents and total tourist and recreational influx. Based on the foregoing, it was concluded that any reservoir selected for recreational development, in addition to being located near the established centers of area growth, should ring the Rend Lake project and be satellite to that project's recreational complex. Thus, Rend Lake will serve as a major attraction in the basin, and the satellite reservoirs will supplement the area's water-related opportunities that would be required for servicing the total recreational demand. This in-depth planning will control the opportunities developed at the satellite reservoirs and provide a flexible, but stable, base that will encourage permanent residential development and industrial and commercial growth. The result will be a plan of development that will permit complete integration of all input factors necessary to provide for a stable and diversified base for growth.

d. Stream augmentation.

(1) Procedures. The supplemental storage required for low-flow augmentation was based on the estimated stream target flows required to maintain specified concentrations of dissolved oxygen acceptable to the State. Monthly target flows were determined for selected increments of time and for variable standards ranging from 3 to 5 milligrams per liter of dissolved oxygen (mg/l DO). Total storage for low-flow augmentation was predicated on first evaluating the base that is required for sustaining a specified level of DO for 95 percent of all low-flow events, the event being defined as those deficient periods (historical basis, period of record) when the natural flow is less than the required target flow established by FWPCA. Further evaluation was then made to determine the additional

increment of supplementation required to insure that for the remainder of the critical period of record, the stream would be maintained at a minimum standard of 3 mg/l DO. This implies a rule-curve for all reservoir operations, with phased augmentation of natural flows. Releases would maintain target flows at the desired standard of DO level within the availability limits of the basic storage block. Subsequent to depletion of the base storage, releases then would be reduced to maintain the minimum 3 mg/l DO target flow for the balance of the deficient period and/or until the base reservoir storage is once more available.

(2) Need evaluation. Once the target flows were established, a preliminary analysis was undertaken to determine the hydrologic feasibility of maintaining the required monthly flows at each of the selected critical load points. Since augmentation of natural flows involves those deficient periods when the natural flow is less than the required target flow, it was apparent that the size and yield capability of the drainage area above the critical point would be a basic design and control consideration. Using the mass flow records of the six gaging stations, comparative yield parameters were established for the various parts of the basin. Thus, to depict either the daily or monthly flow variations, to establish a hydrologic trace, or to determine the yield capability, a percent relationship of the mean discharge (cfs) for any size drainage area under study to that of Plumfield, the control gage, was used as a multiplier of the Plumfield gage flows. Using these yield relationships, computerized routings were made by FWPCA to ascertain the probability of maintaining monthly target flows for 5 mg/l DO, based on the drainage area at the load points. In addition, computerized routings were run for a series of reservoir sites with variable size drainage areas to determine the minimum size drainage area for which a reservoir could be considered in augmenting low flows. The probability analysis was based on an annual capability without regard to extended low-flow durations. This was indicative of the recharge capability of a drainage area and the successful assurance of maintaining the depicted flows by natural runoff. A two-way matrix was used to analyze the success or failure on both a water-year and monthly basis. If failure was indicated, the target flows were changed to provide a lower DO level, and further calculations were made to determine what target flows and DO levels could be maintained. Detailed routings based on daily stream flows were used to verify the degree of DO that could be maintained. Analysis of the various reservoir sites indicated that, for the smaller drainage areas, demands in terms of c.f.s. - per - square mile versus yields in terms of c.f.s. - per - square mile tended to become asymptotic. Based on the ratio of total load-point flow requirement to adjusted mean annual storage equivalent for the reservoir and the percent of failure, it was concluded that a drainage

area of 7 square miles should be established as the minimum size for which a reservoir could be considered in augmenting low flows.

(3) Conclusions. The results of the hydraulic evaluations indicated that acceptable standards of stream quality could be maintained for five of the six critical load points. The exception was in the area of Carbondale where the hydraulic low-flow regimen was complicated by Crab Orchard Reservoir's operational inability to provide dependable releases. Since this reservoir controls approximately 75 percent of the upstream drainage area, it was concluded that low-flow supplementation was not a practical solution to the long-term water quality problems at this load point. Therefore, future water quality must be maintained by other methods such as advance waste treatment or pipeline transfer of waste loads to the Big Muddy River. Since low-flow augmentation is an authorized purpose of Rend Lake, the capability of the Big Muddy to assimilate this possible waste discharge was analyzed. Based on established monthly target flows, it was determined that the induced waste load would not adversely affect the DO level in that reach of the main stem. However, the low-flow characteristics of Crab Orchard Creek required further reevaluation of that reach of stream flowing through the environmental area of Carbondale. Since this community is one of the largest and most rapidly developing urban areas in the basin, it was apparent that there was a need for some degree of low-flow augmentation. Of particular concern was the fact that, in time, this particular reach of Crab Orchard Creek will experience insanitary conditions, particularly from the large volume of various types of pollution induced into the stream from storm runoff. The U. S. Public Health Service indicated the specific need to maintain flushing action; that maintenance of a base flow over and above any return flow (treated wastes) should be guaranteed to minimize the potential hazards to the local residents from vector problems and other health and social nuisances. Based on these governing social concerns, the obvious opportunity to improve the urban area's aesthetics, and Crab Orchard Reservoir's inability to maintain dependable downstream releases, it was concluded that the natural stream flows should be supplemented sufficiently to maintain a minimum base flow. The selected base flow was that calculated to maintain 3 mg/l DO for 100 percent of the time with an assumed minimum of secondary treatment afforded the waste effluent. The calculated DO concentration obtainable and the amount of supplementation required for each load point are shown in TABLE 7. Included is information relative to the watershed main load contributor and control point, applicable drainage area of control point, yield factor adjustments for the Plumfield gage, selected DO standards, and the time-phased amount of supplemental flow required at the load points. The supplemental storage figures do not include

allowances for transmission and evaporational losses necessary for inclusion in reservoir design. This information was furnished the State of Illinois for review and comments by letter dated 28 September 1967. The State replied that the summarized results generally confirm its appraisal of the water quality at the points indicated and that the dissolved oxygen water quality standards, as presented and formulated, were acceptable and satisfactory to the State.

29. ASSIGNMENT OF FUNCTIONS

The functional requirements of the individual reservoirs were based on the services assigned the project in meeting the basin needs. After the flood control storage requirements were established, each reservoir was studied to determine its capability for meeting the individual watershed needs for low-flow supplementation and the concurrent basin need for recreation. Since any reservoir considered would be part of a system for decapitating flood flows, the storage for the other two purposes was analyzed as incremental to that need. Sizing the joint-use pools was based on the dual objectives of meeting the immediate 1980 needs and the concept of full-site utilization. Storage dedication was predicated on first allocating that amount necessary to meet the 1980 low-flow supplemental needs. To this base, a second increment was added, equivalent to the storage required to meet the supplemental low-flow needs for the years 2000 and 2020. This later storage was included as a dual-purpose block, initially dedicated to recreation but subject to subsequent, selective and progressively greater incremental conversion to low-flow augmentation, while still satisfying essentially the same recreational needs. For those reservoirs with site potential not fully utilized, a third storage block was added, dedicated to the single-purpose need of recreation. This storage would have the added value of enhancing the project's contribution to the reorientation of the basin's economic structure by increasing the water-surface acreage and adding to its potential as a tourist attraction. Thus, project formulation and analyses recognize that the larger reservoirs would have an increment of joint-use storage, possibly involving a multiplicity of use on a time-phased basis.

30. CONVERSION OF DUAL-USE POOL

a. Rationale. The concept of a time-phased conversion for any increment of joint-use storage is based on the assumption that the projected needs will become a reality; that storage will be converted from an interim and compatible use to meet these needs; and that, together, the dual, or combination of, uses will not only provide the maximum excess of benefits over costs, but will

TABLE M-7

Water quality hydraulic analysis

Sub-basin	Main load contributor and control point	Applicable drainage area of control point (sq. mi.)	Yield factor	Supplemental storage requirements: Time of demand	Duration (1) (months)	Storage(2) (acre-feet)	Remarks
Beaucoup Crk.	Pinckneyville; Pinckneyville on Beaucoup Creek	222	0.245	1965	5(6)	1,300	DO level of 5 mg/l attainable.
				1970	5(6)	1,600	
				1980	5(6)	2,000	
				2000	6(12)	3,600	
				2020	6(13)	5,200	
Little Muddy Creek	DuQuoin; Confluence Reese Creek and Little Muddy Creek	208	0.225	1965	5(6)	2,900	Yield of drainage area above DuQuoin's sewered outfall insufficient to maintain desired standards. DO level of 5 mg/l attainable for adjusted control point (confluence)
				1970	5(6)	3,400	
				1980	6(12)	4,600	
				2000	17(18)	8,700	
				2020	17(2i)	13,200	
Upper Big Muddy	Mt. Vernon; Confluence Casey Fork and Seven-Mile Creek	76	0.073	1965	5(6)	1,500	Yield of DA above Mt. Vernon outfall insufficient to maintain desired standards. DO level of 4 mg/l for adjusted control point (confluence) attainable based on tertiary treatment provided at Mt. Vernon.
				1970	5(6)	1,700	
				1980	5(8)	2,100	
				2000	17(19)	4,600	
				2020	17(20)	6,700	
Middle Fork	West Frankfort; West Frankfort on Middle Fork	231	0.256	1965	6(11)	4,500	DO level of 5 mg/l attainable.
				1970	6(11)	4,600	
				1980	6(12)	5,900	
				2000	17(18)	9,100	
				2020	17(19)	15,300	

TABLE M-7 (cont'd)

Water quality hydraulic analysis

Sub-basin	Main load contributor and control point	Applicable drainage area of control point (sq. mi.)	Yield factor	Supplemental storage requirements: Time of demand	Duration (1) (months)	Storage (1) (acre-feet)	Remarks
Lake and Pond Creeks	Johnston City; Johnston City on Lake Creek	17					Pollution problem is primarily one of induced mining waste. Experience has proven that low-flow augmentation is not an acceptable solution. Consequently, any analysis has been deferred subject to local action to alleviate the basic problem.
Hurricane Creek	Herrin; Herrin on Hurricane Creek						Drainage area of sub-basin and above load point (Herrin) insufficient in terms of size and yield capability to warrant investigation. Control point moved to main stem, Big Muddy.
Crab Orchard	a. Marion; Confluence Buckley Creek and Crab Orchard Creek	49	0.049	1965	5(8)	1,000	DO level of 4 mg/l attainable. Predicated on present tertiary treatment being provided Marion discharge.
				1970	5(8)	1,300	
				1980	16(18)	1,700	
				2000	17(19)	2,900	
				2020	17(20)	3,800	
	b. Carbondale;[4] Carbondale on Crab Orchard Creek	71[3]	0.070	1965	5(6)	3,800	DO level of 3 mg/l attainable (100% of events). Operation of Crab Orchard Reservoir limiting factor restricting yield available for supplementation.
				1970	5(6)	4,800	
				1980	5(6)	6,600	
				2000	17(18)	11,500	
				2020	17(19)	16,600	

TABLE M-7 (cont'd)

Water quality hydraulic analysis

Sub-basin	Main load contributor and control point	Applicable drainage area of control point (sq. mi.)	Yield factor	Supplemental storage requirement: Time of demand	Duration(1) (months)	Storage(2) (acre-feet)	Remarks
Lower Big Muddy River	Carbondale; Confluence(5) Crab Orchard and Big Muddy River	1,544	1.690	1965	4(5)	6,300	DO level of 5 mg/l attainable
				1970	4(5)	8,100	
				1980	5(6)	11,200	
				2000	5(6)	19,000	
				2020	5(6)	24,700	

(1) Duration of the critical period at the selected control point, based on the target flows established by FWPCA and the natural flows of record adjusted to the control point. Two durations are shown: the first identifying the time increment involved between the initial supplement and maximum accumlative flow deficiency; and the second, in (-), the total time span between initial drawdown to reservoir recovery.

(2) Based on the storage required for satisfying a specific level of DO for 95 percent of all low-flow events plus that additional increase required to insure that, for the remainder of the critical period of record, the stream would be maintained at a minimum storage of 3 mg/l DO.

(3) The 270-square mile drainage area above the control point has been reduced by 199 square miles of drainage area control by Crab Orchard Reservoir to reflect that reservoir's operational inability to provide dependable releases.

(4) Supplementation requirement to maintain standard of 3 mg/l DO 100 percent of the time.

(5) Key control point for low-flow augmentation in that reach of Big Muddy River below Rend Lake. Other control points not shown are Benton (downstream of Rend Lake Dam), Herrin (Hurricane Creek), and Murphysboro.

obtain the full advantages of multiple-purpose developments. Implied is the recognition of a restricted, yet multiple usage of the same storage based on two considerations: (1) to identify the costs necessary to modify the basic project (exclusive of specific facilities), each block of storage has at least two governing parameters, volume and time; and (2) to determine the eventual economic justification of a project purpose, the project cost applicable to each (added) block of storage must be distributed equitably among the purposes served. Hence, there are the additive requirements of specific identification and compatability evaluation of the multiple services or functions provided.

b. Application. Based on the foregoing, the joint-use pool in each of the reservoirs studied was divided into individual storage blocks defined in terms of (1) controlling or consumptive uses; (2) scale of project modifications; and, (3) time. Recreation, essentially non-consumptive in water use, would be compatible even on an incidental basis. However, the degree of compatibility would be a subject of separate analysis ascertaining the effects of project operation (drawdown for consumptive use) on recreation. Scale of project modifications is the ultimate storage need of each controlling purpose at the end of the analysis period (50 years, 1970 -2020). Time is the controlling variable for phasing the magnitude and availability of storage needs, and is the basis for computing the relative value (present-day worth) of each service or function provided. These relative values, in turn, serve as a basis for eventual distribution of project costs. Hence, interim usage is reflected only in terms of identifying project purposes involved in each storage block and the relative values of those functions. Specific costs may or may not be involved.

c. Operational effects on reservoir recreation. To verify the compatibility of dual-use, a procedure was established to determine the effects of downstream releases for low-flow augmentation on the recreational potential of each reservoir. First, the storage required to supplement natural flow was determined. Release (storage) requirements were evaluated on a probability basis for deficient low-flow events, as defined by comparing FWPCA target flows for the selected quality standards to natural flows. The resultant water surface acreage that would be available for at least 75 percent of all low-flow events then was used as the basis for establishing the optimum recreational potential of each reservoir. No allowances were made for evaporational losses in this analysis, since the duration of drawdown is comparatively short and the evaporational losses would be comparable, whether either dual-use or single-purpose is involved. Since these storage requirements and average surface acres were predicated on "low-flow events," the drawdown events, if calculated on an average annual basis, possibly would tend to indicate a greater recreational potential than actually might be experienced. Thus, analysis of the

drawdown effects was on a monthly basis and identified the water surface acres available for usage during those months in the recreational season. Planning for reservoir recreation recognized that there will be a drawdown of varying magnitudes, depending on the severity of drought conditions, and is predicated on a "normal pool" rather than "top of joint-use pool." Use of average annual attendance figures is indicative of this generalized approach in recognizing year-to-year variations dependent upon the weather cycles. Design and location of recreational facilities are planned to operate within a range of elevations for the "normal pool." The hydrologic conditions, and the increased usage and regulation of water by man, require a coordinated approach and recognition of compromise in the ultimate aims of each water purpose with realistic assessment and coexistence in planning for each project purpose. Low-flow releases also will enhance the recreational aspects of the downstream reaches and will provide the base for the ultimate development of recreational parkway and river corridors recommended by the State of Illinois and local interests.

SECTION VI - SELECTION OF BASELINE PLAN

31. ALTERNATIVE PROPOSALS CONSIDERED

a. General. Developments considered for inclusion in the baseline plan were responsive only to those needs pertaining to flood control, drainage, low-flow augmentation in the interest of both water quality control and maintenance of base flow, and general recreation. It was found that the needs of the individual watersheds could be best served by a system of reservoirs and channel improvements impounding and regulating the surface runoff. It was also recognized that because of economical or physical constraints the optimum plan of development may be incapable of completely satisfying all of the projected water- and land-related needs. As part of the plan formulation effort, joint coordinated planning was undertaken by the construction agencies to identify specific need centers and within that framework, establish various alternative projects or group of projects capable of meeting these needs. This was done on a comparative basis utilizing estimates of benefits and costs based on 1967 price levels.

b. Soil Conservation Service proposals. To meet the primary needs of the basin, the Soil Conservation Service studied some 104 headwater sites for reservoir development in 13 of the 15 watersheds. The remaining two watersheds, Cedar Creek and Kinkaid Creek were not studied since comprehensive plans of improvement had already been established and were in various stages of development. Preliminary screenings subsequently reduced the number of watersheds warranting consideration from 13 to 10 and the number of reservoirs from 104 to 80. An economic evaluation indicated that agricultural-related developments in watersheds numbers: 1 - Lower Big Muddy River, 4 - Lower Beaucoup Creek, and 9 - Central Big Muddy River could not be justified. Furthermore, flood control and drainage improvements could not be justified in that part of Watershed No. 7, Crab Orchard Creek, located below Crab Orchard Reservoir. Each of the remaining 80 reservoir sites was then evaluated relative to its topographic potential for additional storage and multiple usage. Hydraulic screening established that five reservoirs had sufficient storage-yield capability, either individually or in combination, to meet the low-flow augmentation needs for four out of six load points. Twelve reservoirs were identified as having a recreational potential. However, application of the minimum water-surface area criteria, together with the need for area distribution and a comparative need-efficiency evaluation, reduced this number to six for initial consideration. In addition, the need for main stem, lateral and sub-lateral channel improvements was established in all 10 watershed areas to help drain wetlands in and adjacent to the flood plains. Some 349.9 miles of main channel improvements were designed and costed for development along the principal tributaries. These improvements would supplement the detention structures in encouraging the agricultural enhancement of the protected areas. In addition, these main channel improvements would permit development of approximately 875.6

miles of laterals and sub-laterals to provide drainage outlets for acreage in and adjacent to the flood plain. The 80 reservoirs selected for final comparative analysis contained storage amounting to 189,920 acre-feet for flood reduction, including sediment storage, with an additional 132,410 acre-feet for potential allocation in meeting the needs of recreation and/or low-flow augmentation. Total cost of the reservoirs was estimated at $31,248,200. Total costs of the 1,225.5 miles of channel improvements was estimated at $12,200,300 of which $7,099,800 was for installation of the main channels. In addition, an expenditure of $21,306,400 was estimated as the cost required for installation of land treatment measures in the 10 watersheds. Total cost of the foregoing improvements amounted to $64,754,900, based on July 1967 price level.

c. Corps of Engineers proposals. Based on the composition of needs and redevelopment objectives, it was concluded that the interest of the basin would be best served if conflicts with the Soil Conservation Service's headwater reservoirs were minimized. This would be required if the concerted effort to enhance the local agricultural productive output and efficiency is to be achieved. Since channel improvements and on-farm drainage systems are essentially last-added increments to the reservoirs and directly related to the land treatment proposals, it was concluded that local participation would be facilitated if most of the improvements were implemented under the Public Law 566 program. Due to the diversity of improvements, it was also decided that multiple Federal agency involvement in the construction program should be minimized since in this area a basically single Federal-local sponsor relationship would be beneficial. Otherwise, planning could become too complex and lead to haphazard phasing and development in each of the watersheds. Consequently, the Corps restricted its investigative role in this study, considering only those reservoir projects capable of meeting the predominant water resource needs, and then only in those watersheds where low-flow augmentation was a definite water need. This procedure automatically insured selection of reservoirs with a good distribution pattern, close to the main growth centers, enhancing the project's recreational potential and its contribution (tourism) to the area's economic reorientation. On this basis, preliminary studies involved consideration of some 57 reservoir structures, 6 of which were retained for detailed analysis. Screening was confined essentially to the individual site's capability and efficiency in meeting the water-related requirements. Design of these reservoirs provided a total storage equivalent of 177,700 acre-feet, of which 48,600 acre-feet was provided for flood control and sediment storage, and the remaining 129,100 for multiple usage, both low-flow augmentation and recreation. Total cost of the six projects was estimated at $63,467,100, based on July 1967 price levels.

d. Summary. TABLE 8 lists the reservoirs proposed for development by the Soil Conservation Service and the Corps of Engineers

in each of the ten watersheds. TABLE 9 presents the channel improvements recommended for installation in each watershed. TABLE 10 lists the number of acres in each watershed on which land treatment measures are required. In all cases, the costs shown are based on July 1967 price levels. Shown on PLATE 3 are the 86 projects proposed by the two construction agencies.

TABLE M-8

Proposed reservoirs

	Sediment storage ac-ft	F.C. storage ac-ft	Multiple-purpose storage ac-ft	Total storage ac-ft	Cost ($)(4)
Watershed No. 5					
Galum Creek					
SCS					
5-1	800	2,100		2,900	142,000
5-3A	300	1,600		1,900	140,200
5-4	1,200	3,400		4,600	220,900
5-6	900	3,000		3,900	234,700
5-7	620	2,100	7,760(1)	10,480	1,402,950
5-10	600	1,600		2,200	142,600
5-11	200	800		1,000	73,600
5-12	1,200	3,800		5,000	430,700
Corps					
		N O N E			
Watershed No. 6					
Upper Beaucoup Creek					
SCS					
6-3*	500	1,600		2,100	191,800
6-4*	300	1,000		1,300	87,400
6-5A*	2,000	6,800	8,200(2)	17,000	839,800
6-7*	400	1,100		1,500	94,500
6-8	400	800		1,200	93,600
6-9	300	800		1,100	117,000
6-10	400	1,100		1,500	136,000
6-11	1,400	4,700	4,200(1)	10,300	1,114,950
6-13	1,400	4,500		5,900	331,700
6-14	500	1,800		2,300	126,600
6-15	400	1,200		1,600	121,800
6-16	300	900		1,200	86,400
6-17	1,400	4,600		6,000	316,600
6-18A	900	2,100	6,600(1)	9,600	1,253,500
Corps					
-34*	4,900	7,200	22,800(3)	34,900	12,568,800
Watershed No. 7					
Crab Orchard Creek					
SCS					
7-6	300	1,000		1,300	102,800
7-7*	600	1,800	6,400(1)	8,800	1,581,400
7-8A*	1,000	2,000	5,550(2)	8,550	661,000
Corps					
-12*	1,500	1,200	6,100(3)	8,800	5,753,000
-16A	1,800	---	19,000(3)	20,800	7,500,300
Watershed No. 8					
Little Muddy River					
SCS					
8-1B	300	1,000		1,300	122,500
8-2*	400	1,100		1,500	105,100
8-3*	600	1,800		2,400	151,100
8-4*	600	1,800		2,400	159,800
8-5*	200	600		800	83,200
8-6*	700	2,300		3,000	175,600
8-7*	400	1,300		1,700	173,600
8-8*	600	1,600		2,200	189,000
8-9A	300	800		1,100	95,800
8-10	1,200	4,000	4,200(1)	9,400	1,694,300
Corps					
-35*	7,900	14,500	25,700(3)	48,100	17,526,900
Watershed No. 10					
Hurricane Creek					
SCS					
10-1	700	2,200	11,600(1)	14,500	1,174,600
Corps					
		N O N E			
Watershed No. 11					
Lake and Pond Creek					
SCS					
11-2	200	600		800	64,800
11-3	1,000	4,400		5,400	397,400
Corps					
		N O N E			

*Alternatives for meeting the total or portions of the basin's needs.

(1) Recreation only.
(2) Low-flow augmentation.
(3) Dual use - recreation and low-flow augmentation.
(4) Includes discounted worth of future (2000 and 2020) recreational developments where applicable based on July 1967 price levels.

TABLE M-8 (cont'd)

Proposed reservoirs

	Sediment storage ac-ft	F.C. storage ac-ft	Multiple-purpose storage ac-ft	Total storage ac-ft	Cost ($)(4)
Watershed No. 12					
Middle Fork Creek					
SCS					
12-1*	1,700	5,600	17,000(3)	24,300	2,440,200
12-3	400	800	3,100(1)	4,300	812,900
12-4	100	400		500	73,500
12-5A	300	800		1,100	105,900
12-5B	300	1,100		1,400	100,100
12-6A	300	1,500		1,800	151,000
12-7A	500	1,600		2,100	158,800
12-9*	1,200	3,400	4,500(2)	9,100	674,000
12-10*	400	1,300		1,700	175,000
12-11	200	700		900	60,600
12-12A	200	500		700	158,600
12-13	700	2,400		3,100	242,500
Corps					
-7*	2,800	3,700	40,900(3)	47,400	12,153,900
Watershed No. 13					
Gun Creek					
SCS					
13-1	200	600		800	114,800
13-2	200	500		700	110,800
13-3A	400	1,200		1,600	158,700
13-4	200	700		900	171,900
Corps					
		N O N E			

(1) Recreation only.
(2) Low-flow augmentation.
(3) Dual use - recreation and low-flow augmentation.
(4) Includes discounted worth of future (2000 and 2020) recreational developments where applicable based on July 1967 price levels.

*Alternatives for meeting the total or portions of the basin's needs.

	Sediment storage ac-ft	F.C. storage ac-ft	Multiple-purpose storage ac-ft	Total storage ac-ft	Cost ($)(4)
Watershed No. 14					
Upper Big Muddy River					
SCS					
14-1	600	1,900		2,500	204,600
14-2	1,000	3,000		4,000	360,200
14-3	200	600		800	104,500
14-4	200	600		800	115,900
14-5	200	500		700	116,600
14-6	500	1,600	7,400	9,500	1,102,600
14-7	2,800	9,100	12,900	24,800	2,430,700
14-8	200	700		900	117,900
14-9A	200	600		800	123,800
14-10A	300	800		1,100	197,000
14-12	1,800	5,100	18,000(1)	24,900	1,487,000
14-14	500	1,400		1,900	219,600
14-15	800	2,100		2,900	288,700
Corps					
		N O N E			
Watershed No. 15					
Casey Fork Creek					
SCS					
15-1A	600	2,000		2,600	209,400
15-2A	200	600		800	145,700
15-3A*	600	1,500	4,600(1)	6,700	1,040,100
15-5	300	1,000		1,300	159,300
15-6	100	100		200	38,700
15-7	100	100		200	40,700
15-8*	1,200	2,900	10,400(2)	14,500	1,511,100
15-9	200	600		800	90,000
15-10	100	300		400	125,300
15-11	400	1,100		1,500	171,900
15-13A	300	1,000		1,300	244,600
15-14	200	500		700	134,700
15-15	200	600		800	127,200
Corps					
-5*	1,800	1,300	14,600(3)	17,700	7,964,200

TABLE M-9

Proposed channel improvements

Watersheds	Mains		Laterals & Sublaterals	
	Length of improvements (miles)	Installation cost ($) 1/	Length of improvements (miles)	Installation cost ($)
No. 2 Cedar Creek	----	----	----	----
No. 5 Galum Creek	21.6	381,900	47.8	273,900
No. 6 Upper Beaucoup Creek	66.9	1,167,800	102.7	655,900
No. 7 Crab Orchard Creek 2/	9.8	203,900	99.0	529,300
No. 8 Little Muddy River	66.9	1,684,200	141.0	872,000
No. 10 Hurricane Creek	6.7	117,000	28.1	110,600
No. 11 Lake and Pond Creeks	28.5	632,000	83.7	475,000
No. 12 Middle Fork Creek	47.8	1,388,400	162.8	839,300
No. 13 Gun Creek	5.9	89,600	45.8	241,200
No. 14 Upper Big Muddy	44.8	768,500	75.5	686,100
No. 15 Casey Fork Creek	51.0	666,500	89.2	417,200
Total	349.9	7,099,800	875.6	5,100,500

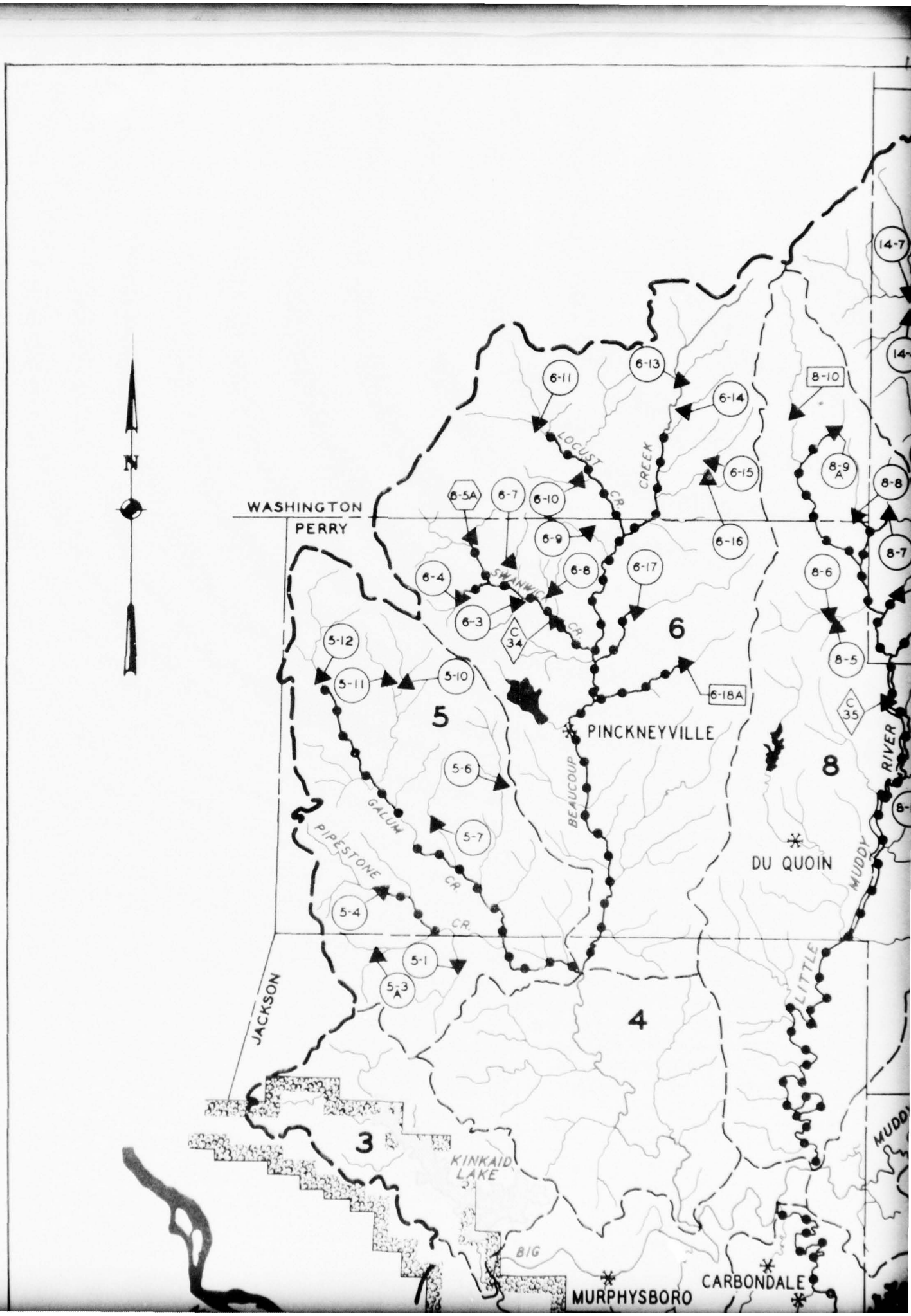
1/ Based on July 1967 price levels.
2/ Area above Crab Orchard Lake.

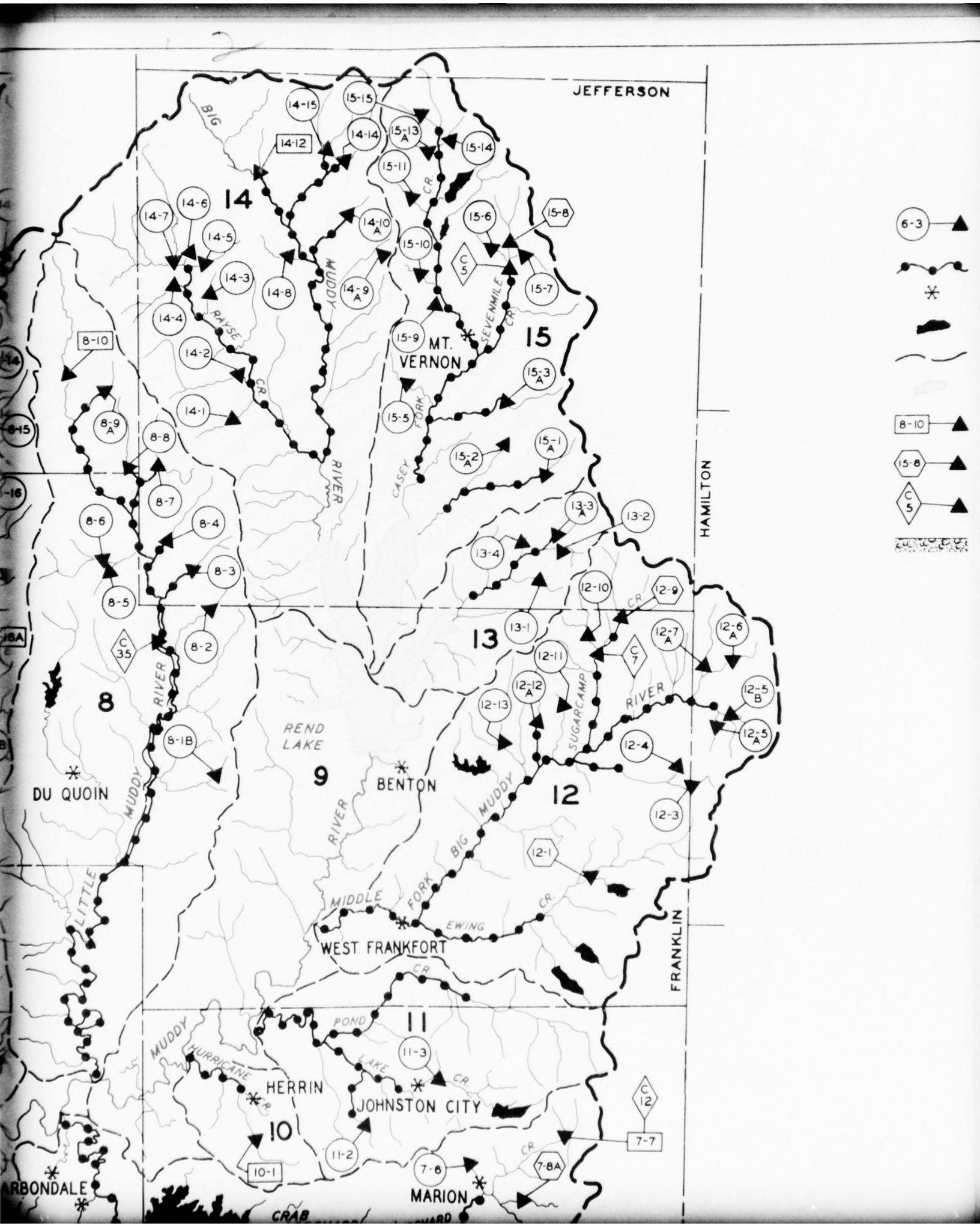
TABLE M-10

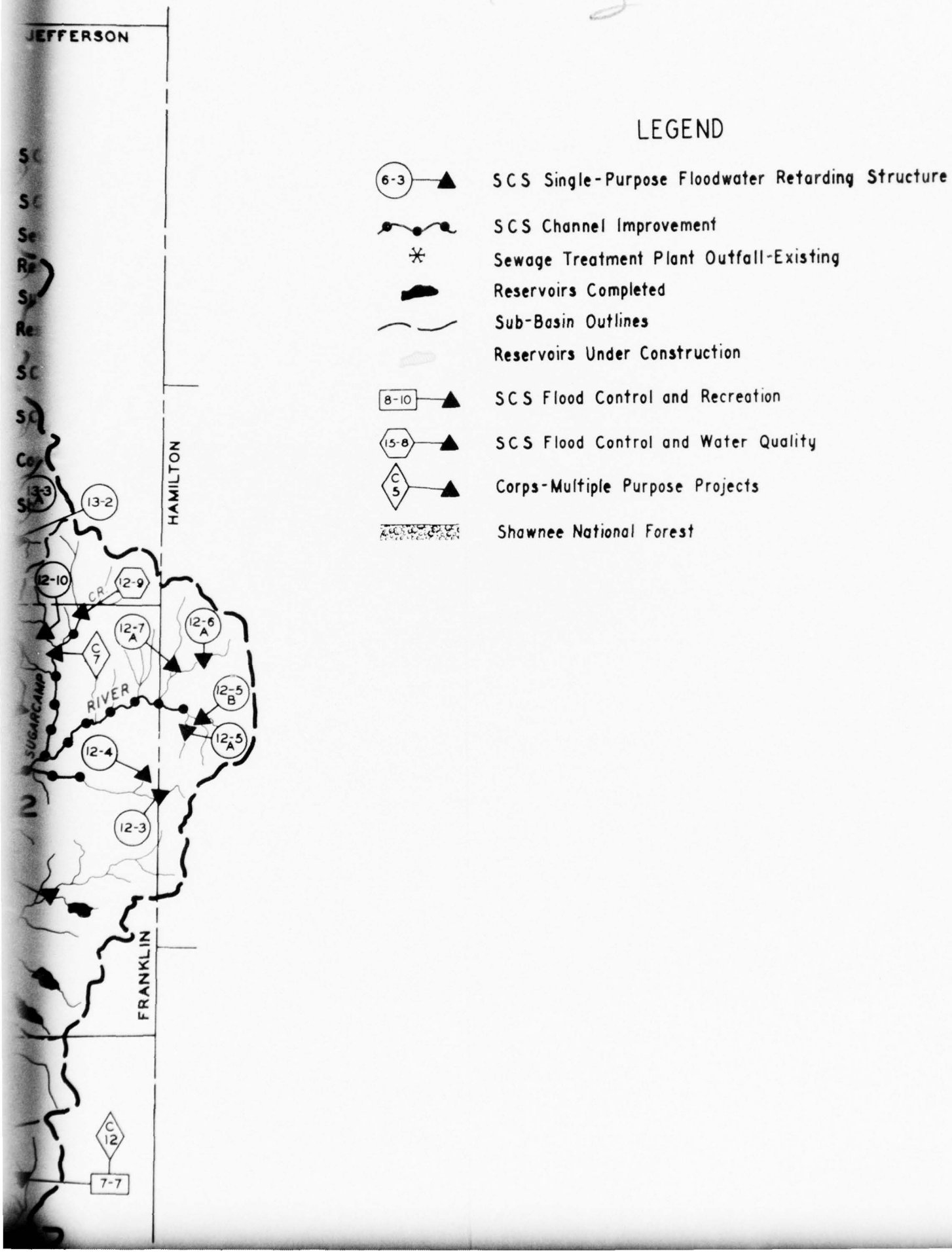
Proposed land treatment requirements

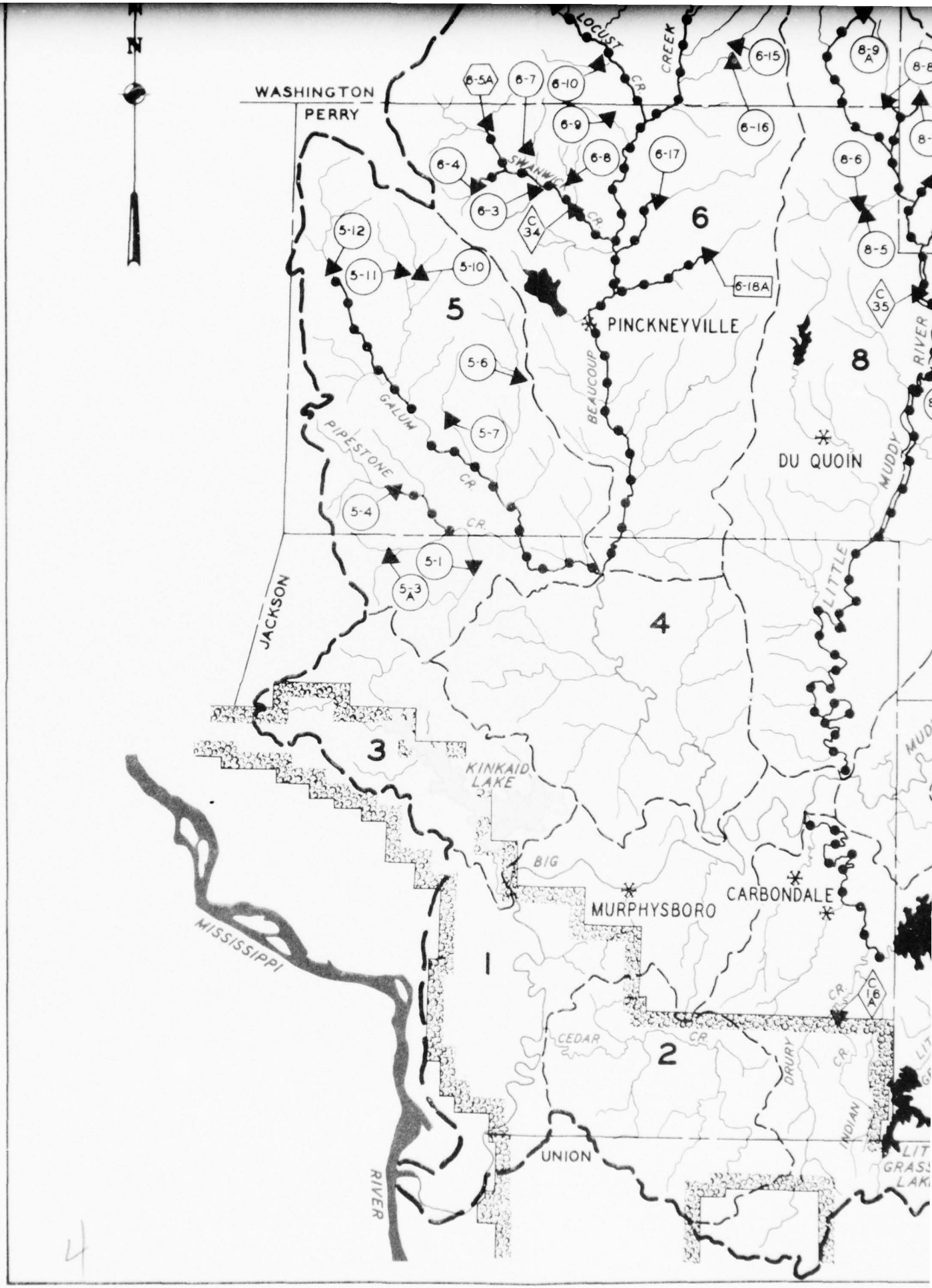
Watershed	Acres	Costs ($) 1/
No. 5 Galum Creek	51,960	2,654,500
No. 6 Upper Beaucoup	99,720	5,116,400
No. 7 Crab Orchard	75,200	1,874,325
No. 8 Little Muddy	92,460	4,732,700
No. 10 Hurricane Creek	8,600	214,475
No. 11 Lake and Pond	36,290	904,525
No. 12 Middle Fork	82,690	2,070,150
No. 13 Gun Creek	16,840	419,625
No. 14 Upper Big Muddy	80,440	1,995,550
No. 15 Casey Fork Creek	53,130	1,324,150
TOTAL	597,330	21,306,400

1/ Based on July 1967 price levels.

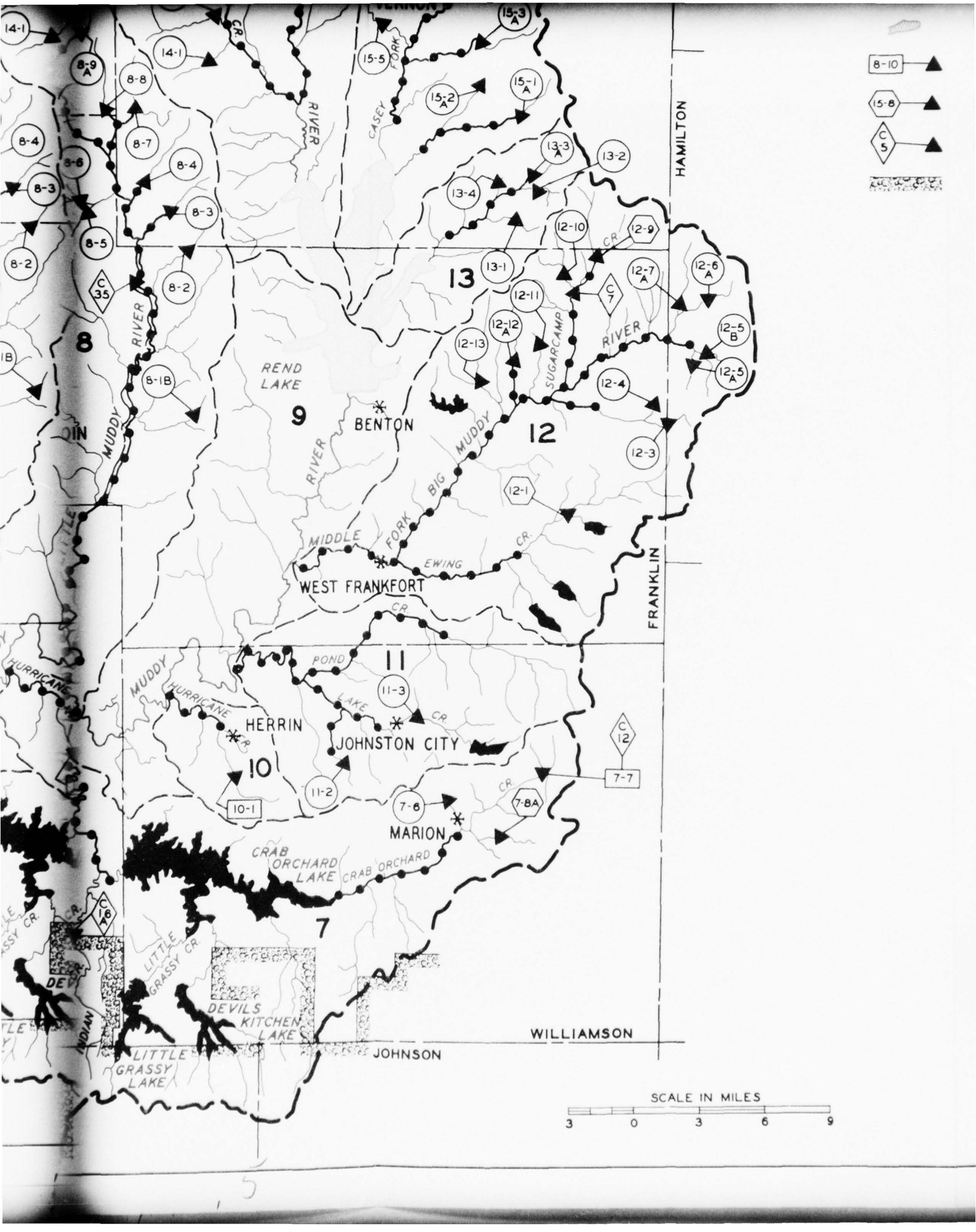

N
WASHINGTON
PERRY
JACKSON
6-11
6-13
6-14
6-15
6-16
6-17
6-5A
6-7
6-10
6-9
6-8
6-4
6-3
C 34
6-12
5-12
5-11
5-10
5-6
5-7
5-4
5-1
5-3A
6-18A
8-10
8-9A
8-8
8-7
8-6
8-5
C 35
14-7
14-
LOCUST CREEK CR.
SWANWICK CR.
BEAUCOUP CR.
GALUM PIPESTONE CR.
CR.
LITTLE MUDDY RIVER
MUDDY
KINKAID LAKE
BIG
PINCKNEYVILLE
DU QUOIN
MURPHYSBORO
CARBONDALE
3
4
5
6
8


JEFFERSON
HAMILTON
FRANKLIN
14
15
13
8
9
12
11
10
MT. VERNON
REND LAKE
DU QUOIN
BENTON
WEST FRANKFORT
JOHNSTON CITY
HERRIN
MARION
ARBONDALE
BIG MUDDY RIVER
RAYSE CR.
CASEY FORK
SEVENMILE CR.
SUGARCAMP CR.
MIDDLE FORK
EWING CR.
LITTLE MUDDY
HURRICANE CR.
POND LAKE
CRAB
14-15
15-15
14-14
15-13A
15-14
14-12
15-11
14-6
14-7
14-5
14-10A
15-6
15-8
C 5
14-3
14-8
14-9A
15-10
15-7
14-4
15-9
14-2
8-10
15-3A
14-1
8-9A
8-8
15-5
15-1A
15-2A
8-7
13-3A
13-2
8-6
8-4
13-4
8-3
12-10
12-9
8-5
13-1
12-7A
12-6A
C 35
8-2
12-11
C 7
12-12A
12-5B
12-13
12-5A
8-1B
12-4
12-3
12-1
11-3
7-7
C 12
11-2
7-8
7-8A
10-1
6-3
8-10
15-8
C 5


JEFFERSON
HAMILTON
FRANKLIN
SUGARCAMP
RIVER
CR
13-3
13-2
12-10
12-9
12-7 A
12-6 A
C 7
12-5 B
12-5 A
12-4
12-3
C 12
7-7
LEGEND
6-3
SCS Single-Purpose Floodwater Retarding Structure
SCS Channel Improvement
Sewage Treatment Plant Outfall-Existing
Reservoirs Completed
Sub-Basin Outlines
Reservoirs Under Construction
8-10
SCS Flood Control and Recreation
15-8
SCS Flood Control and Water Quality
C 5
Corps-Multiple Purpose Projects
Shawnee National Forest


N
WASHINGTON
PERRY
LOCUST
CREEK
CR.
6-5A
6-7
6-10
6-9
6-15
8-9A
6-16
6-4
SWANWICK
6-8
6-17
6-6
6-3
C 34
6
8-5
5-12
5-11
5-10
6-18A
C 35
5
PINCKNEYVILLE
8
RIVER
5-6
BEAUCOUP
GALUM
5-7
PIPESTONE
CR.
DU QUOIN
MUDDY
5-4
CR.
5-1
5-3A
JACKSON
LITTLE
4
3
KINKAID
LAKE
BIG
MURPHYSBORO
CARBONDALE
MISSISSIPPI
1
C 16A
CR.
CEDAR
CR.
2
DRURY
CR.
INDIAN
UNION
RIVER
LIT
GRASS
LAK

4


8-10
15-8
C 5
HAMILTON
FRANKLIN
WILLIAMSON
JOHNSON
BENTON
WEST FRANKFORT
HERRIN
JOHNSTON CITY
MARION
REND LAKE
CRAB ORCHARD LAKE
DEVILS KITCHEN LAKE
LITTLE GRASSY LAKE
MUDDY RIVER
BIG MUDDY RIVER
MIDDLE FORK
CASEY FORK
SUGARCAMP CR.
POND LAKE
EWING CR.
HURRICANE CR.
LITTLE GRASSY CR.
CRAB ORCHARD
8
9
10
11
12
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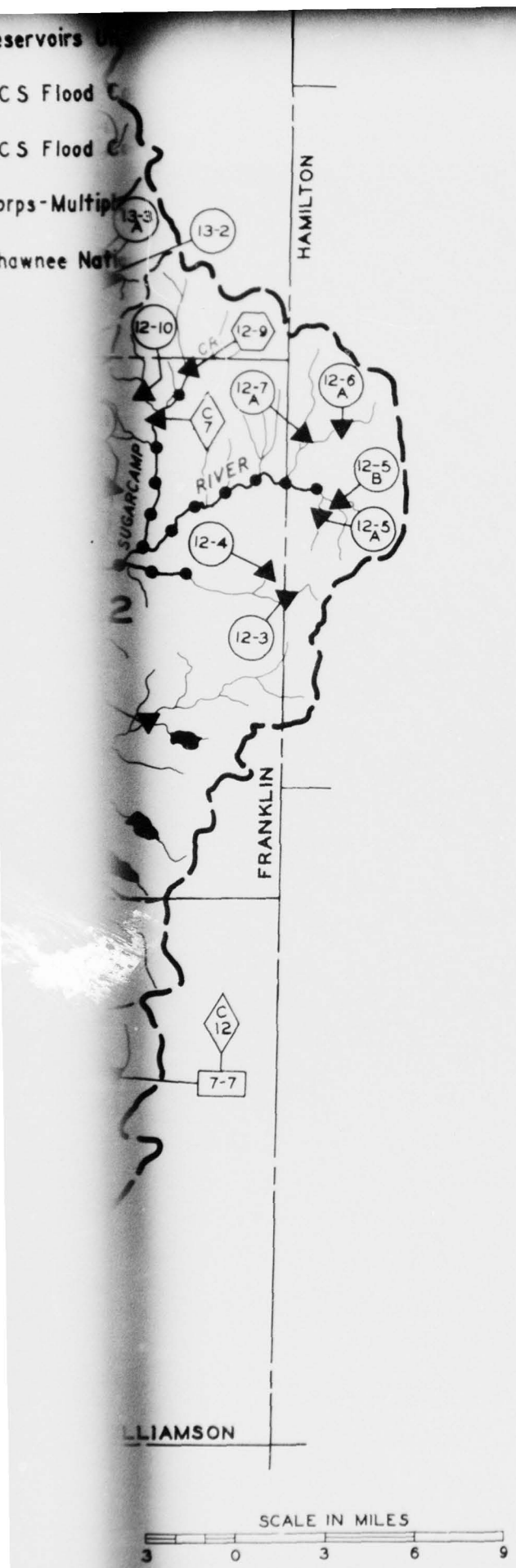
7
SCALE IN MILES
3 0 3 6 9



STRUCTURAL IMPROVEMENTS CONSIDER

BIG MUDDY RIVER BASIN, ILLINIO

PLA

32. SELECTION OF BASELINE PLAN

a. Criteria. The composition of the baseline plan was established by determining the optimum plan of development in each of the 10 watersheds for which action programs were recommended. This determination was based on a procedure analyzing each project and increment thereof as part of a total hydraulic and economic system for that particular watershed. Thus, to identify the optimum plan of improvement for each watershed, a comparative evaluation first was undertaken between those projects that were formulated to meet all or portions of the same needs. Supplemental to these projects would be single-purpose and multi-purpose projects required to meet both the remainder of the watershed's needs and those of the basin allocated to the particular growth center within the watershed boundaries. The comparative analysis involved an evaluation of the level of investment relative to creditable beneficial returns and the degree of achievement in meeting the needs. This procedure identified the scale of development that would provide maximum net benefits. In all cases, the engineering and economic feasibility and optimization of each project(s) had been established by the sponsoring agency.

b. Rationale. The optimum scale of development is that economic point at which the net benefits (excess of benefits over costs) are at a maximum. Net benefits are maximized if the scale of development is extended to the point where the benefits added by the last increment, be it project or separable segment of a project, are equal to the cost of adding that increment. Each competitive reservoir was analyzed on an individual basis to insure the "best use" of that development by obtaining the greatest excess of benefits over costs. The analysis was based on a functional assignment relative to the storage provided and the needs of the watershed and basin as a whole. The evaluation involved alternately rededicating and comparing the worth of each storage increment selected for single or dual use. Benefits and costs were expressed on comparable quantitative economic terms to the fullest extent possible. Since each purpose varies in its competitiveness, when expressed in economic terms only, an analytical constraint was imposed on the comparative analysis. This constraint restricted selection of the best plan of improvement to a maximization of net benefits, creditable to the basic service or product provided. Inclusion of such induced benefits as, say, tourism, would tend to over-emphasize recreational development to the detriment of the other needs and possibly prevent total achievement of the study's objectives.

c. Comparative economic analysis. The primary needs in five of the ten watersheds were confined to the agricultural-related problems of flood control and drainage. These five watersheds were: No. 5, Galum Creek; No. 10, Hurricane Creek; No. 11, Lake and Pond Creeks, No. 13, Gun Creek; and No. 14, Upper Big Muddy River. In each of these watersheds the Soil Conservation Service

had prepared a plan of improvement optimized in terms of economics and systemized flood control hydraulics. While there also was a limited potential to meet a minor increment of the basin's overall recreational needs, it was found that the initial phase could be more economically and effectively met by projects in other watersheds. Therefore, the recommended plan of improvement for these five watersheds included 28 single-purpose flood control reservoirs and 388.4 miles of channel improvements. The alternative proposals which required a comparative evaluation were located in the remaining five watersheds, namely: No. 6, Upper Beaucoup Creek; No. 7, Crab Orchard Creek (Upper portion only); No. 8, Little Muddy River; No. 12, Middle Fork Creek; and No. 15, Casey Fork Creek. Of the 52 structures proposed for consideration by the Soil Conservation Service, 35 were single-purpose reservoirs designed as part of a system that would affect the required flood control hydraulic gradient. The other 17 were the multiple-purpose projects which were considered as functional alternatives to five of the six proposed by the Corps of Engineers. Consequently, the final comparative evaluation involved just 22 reservoirs with varying usage, costs, and benefits, and only 207.9 of the remaining 837.1 miles of channel improvements which were designed as last-added increments to the reservoir system. Shown in TABLES 11 through 15 are the maximization analysis (maximum excess of benefits over cost) for each of the latter five watersheds. Presented are data regarding: the comparative evaluations optimizing those individual projects that have the potential for multiple-use development; the comparative evaluations between those projects or groups of projects formulated to meet all or portions of the same needs; those increments of the system supplemental to the alternative projects and required to meet the remainder of the established needs; and the combination of reservoirs selected as the best from both an effectiveness and efficiency standpoint in meeting that portion of the local area and basin needs within the watershed.

d. Summary. The maximization analyses resulted in reducing the 22 reservoirs under consideration to 7 and, in some instances, reformulated and reallocated the storage function of those projects. Also the 207.9 miles of channel improvements were deferred due to changes in hydraulic control and potential of a higher land use. The baseline plan, as finally formulated, consists of 71 reservoirs located throughout the 10 watersheds, land treatment measures, and 1,017.6 miles of main stem, laterals and sub-lateral channel improvements. The two reservoirs approved for construction under Public Law 566 in Watershed No. 2, Cedar Creek, would be additive, based on the assumption that they may be required to meet the projected water supply deficiency of Carbondale.

TABLE M-11

Maximization for Watershed #6 - Upper Beaucoup Creek
Reservoirs only

	Alternatives							Reservoir Combinations	
	A-1 Corps res. 34 w/FC	A-2 Corps res. 34 w/o FC	A-3 SCS res. #6-3	A-4 SCS res. #6-4	A-5 SCS res. #6-5A	A-6 SCS res. #6-7	A-7 SCS res. Group A	C-1 A-7 + A-1	C-2 A-7 + A-3 + A-4 + A-5 + A-6
A. Benefits ($)									
1. National									
(a) Flood control	148,100	-	21,400	12,800	92,700	15,700	303,000	451,000	445,600
(b) Water quality	107,200	107,200	-	-	107,200	-	-	107,200	107,200
(c) Recreation	578,400	601,200	-	-	-	-	103,500	681,900	103,500
Subtotal	833,700	708,400	21,400	12,800	199,900	15,700	406,500	1,240,200	656,300
2. Regional									
(a) Flood control	15,700	-	2,300	1,300	9,800	1,700	32,100	47,800	47,200
(b) Local economic developments	680,100	680,100	-	-	-	-	89,500	769,600	89,500
Subtotal	695,800	680,100	2,300	1,300	9,800	1,700	121,600	817,400	136,700
3. Total accumulative benefits	1,529,500	1,388,500	23,700	14,100	209,700	17,400	528,100	2,057,600	793,000
B. Costs ($)									
1. Project costs	12,568,800	12,654,000	191,800	87,400	839,800	94,500	2,800,000	15,368,800	4,013,500
2. Annual charges									
(a) Interest & amortization	425,800	428,700	6,500	3,000	28,500	3,200	94,900	520,700	136,100
(b) Operation & maintenance	152,200	156,800	500	200	2,400	300	68,400	220,600	71,800
(c) Total	578,000	585,500	7,000	3,200	30,900	3,500	163,300	741,300	207,900
C. Excess of benefits over costs ($)									
1. National	255,700	122,900	14,400	9,600	169,000	12,200	243,200	498,900*	448,400
2. National and regional	951,500	803,000	16,700	10,900	178,800	13,900	364,800	1,316,300	585,100

Group A includes SCS 6-8; 6-9; 6-10; 6-11; 6-13; 6-14; 6-15; 6-16; 6-17; 6-18A

* Best combination of reservoirs to meet that portion of the local area and basin needs within the watershed.

TABLE M-12

Maximization for Watershed #7 - Upper Crab Orchard Creek
Reservoirs only

	Alternatives						Reservoir Combinations		
	A-1 Corps res. 12 w/FC	A-2 SCS res. #7-6	A-3 SCS res. #7-7	A-4 SCS res. #7-7 w/WQ	A-5 SCS res. #7-8A w/WQ	A-6 SCS res. #7-8A	C-1 A-2 + A-3 + A-5	C-2 A-1 + A-2 + A-6	C-3 A-2 + A-4 + A-6
A. Benefits ($)									
1. National									
(a) Flood Control	62,400	36,100	62,400	62,400	65,700	65,700	164,200	164,200	164,200
(b) Water quality	141,000	-	-	141,000	141,000	-	141,000	141,000	141,000
(c) Recreation	130,700	-	148,500	130,700	-	-	148,500	130,700	130,700
Subtotal	334,100	36,100	210,900	334,100	206,700	65,700	453,700	435,900	435,900
2. Regional									
(a) Flood control	6,700	3,800	6,700	6,700	7,000	7,000	17,500	17,500	17,500
(b) Local economic developments	214,600	-	214,600	214,600	-	-	214,600	214,600	214,600
Subtotal	221,300	3,800	221,300	221,300	7,000	7,000	232,100	232,100	232,100
3. Total accumulative benefits	555,400	39,900	432,200	555,400	213,700	72,700	685,800	668,000	668,000
B. Costs ($)									
1. Project costs	5,753,000	102,800	1,581,400	1,475,200	661,000	148,600	2,344,300	6,004,400	1,726,600
2. Annual charges									
(a) Interest & amortization	194,900	3,500	53,600	50,000	21,700	5,000	78,800	203,400	58,500
(b) Operation & maintenance	53,000	400	76,100	72,500	23,600	400	100,100	53,800	73,300
(c) Total	247,900	3,900	129,700	122,500	45,300	5,400	178,900	257,200	131,800
C. Excess of benefits over costs ($)									
1. National	86,200	32,200	81,200	211,600	161,400	60,300	274,800	178,700	304,100*
2. National and regional	307,500	36,000	302,500	432,900	168,400	67,300	506,900	410,800	536,200

* Best combination of reservoirs to meet that portion of the local area and basin needs within the watershed.

TABLE M-13

Maximization for Watershed #8 - Little Muddy River
Reservoirs only

	Alternatives				Reservoir Combinations	
	A-1 Corps res. #35 w/FC	A-2 Corps res. #35 w/o FC	A-3 SCS res. Group A	A-4 SCS res. Group B	C-1 A-3 + A-4	C-2 A-1 + A-3
A. Benefits ($)						
1. National						
(a) Flood control	318,200	-	31,000	357,000	388,000	349,200
(b) Water quality	172,000	172,000	-	-	-	172,000
(c) Recreation	922,600	1,051,000	153,500	-	153,500	1,076,100
Subtotal	1,412,800	1,223,000	184,500	357,000	541,500	1,597,300
2. Regional						
(a) Flood control	34,900	-	3,400	39,200	42,600	38,300
(b) Local economic developments	1,216,100	1,216,100	179,200	-	179,200	1,395,300
Subtotal	1,251,000	1,216,100	182,600	39,200	221,800	1,433,600
3. Total accumulative benefits	2,663,800	2,439,100	367,100	396,200	763,300	3,030,900
B. Costs ($)						
1. Project costs	17,526,900	17,964,700	1,912,600	1,037,200	2,949,800	19,439,500
2. Annual charges						
(a) Interest & amortization	593,800	608,700	54,600	35,100	89,700	648,400
(b) Operation & maintenance	223,000	248,800	77,900	3,000	80,900	300,900
(c) Total	816,800	857,500	132,500	38,100	170,600	949,300
C. Excess of benefits over costs ($)						
1. National	596,000	365,500	52,000	318,900	370,900	648,000*
2. National and regional	1,847,000	1,581,600	234,600	358,200	592,700	1,081,600

Group A includes: 8-1B; 8-9A;8-10

Group B includes: 8-2; 8-3; 8-4; 8-5; 8-6; 8-7; 8-8

* Best combination of reservoirs to meet that portion of the local area and basin needs within the watershed.

TABLE M-14

Maximization for Watershed #12 - Middle Fork Creek
Reservoirs only

	Alternatives								Reservoir Combinations	
	A-1 Corps res. #7 w/o F.C.	A-2 Corps res. #7 w/F.C.	A-3 SCS res. #12-10	A-4 SCS res. #12-9	A-5 SCS res. #12-1	A-6 SCS res. #12-1	A-7 SCS res. #12-1	A-8 SCS res. Group A	C-1 A-3 + A-4 + A-5 + A-8	C-2 A-2 + A-6 + A-8
A. Benefits ($)										
1. National										
(a) Flood control	-	112,500	29,300	76,400	128,600	128,600	128,600	225,100	459,400	466,200
(b) Water quality	59,300	59,300	-	12,500	46,800	-	-	-	59,300	59,300
(c) Recreation	757,600	711,200	-	-	153,500	416,300	-	-	153,500	1,127,500
Subtotal	816,900	883,000	29,300	88,900	328,900	544,900	128,600	225,100	672,200	1,653,000
2. Regional										
(a) Flood control	-	12,100	3,100	8,200	13,900	13,900	13,900	24,200	49,400	50,200
(b) Local economic developments	876,500	876,500	-	-	179,200	482,700	482,700	-	179,200	1,359,200
Subtotal	876,500	888,600	3,100	8,200	193,100	496,600	496,600	24,200	228,600	1,409,400
3. Total accumulative benefits	1,693,400	1,771,600	32,400	97,100	522,000	1,041,500	625,200	249,300	900,800	3,062,400
B. Costs ($)										
1. Project costs	12,312,000	12,153,900	175,500	674,000	2,440,200	3,647,400	477,300	1,199,900	4,489,600	17,001,200
2. Annual charges										
(a) Interest & amortization	417,100	411,800	6,000	22,900	82,700	123,600	16,200	40,700	152,300	576,100
(b) Operation & maintenance	179,000	169,800	600	23,600	88,200	130,800	1,500	3,700	116,100	304,300
(c) Total	596,100	581,600	6,600	46,500	170,900	254,400	17,700	44,400	268,400	880,400
C. Excess of benefits over costs ($)										
1. National	220,800	301,400	22,700	42,400	158,000	290,500	110,900	180,700	403,800	772,600*
2. National and regional	1,097,300	1,190,000	25,800	50,600	351,100	787,100	607,500	204,900	632,400	2,182,000

Group A includes: 12-3; 12-4; 12-5A; 12-5B; 12-6A; 12-7A; 12-11; 12-12A; 12-13

* Best combination of reservoirs to meet that portion of the local area and basin needs within the watershed.

TABLE M-15

Maximization for Watershed #15 - Casey Fork Creek
Reservoirs only

	Alternatives					Reservoir Combinations	
	A-1 Corps res. #5 w/o FC	A-2 Corps res. #5 w/FC	A-3 SCS res. #15-8 w/o Rec	A-4 SCS res. Group A	A-5 SCS res. Group B	C-1 A-2 + A-4	C-2 A-3 + A-5
A. Benefits ($)							
1. National							
(a) Flood control	-	72,200	72,200	228,600	228,600	300,800	300,800
(b) Water quality	212,900	212,900	212,900	-	-	212,900	212,900
(c) Recreation	292,100	274,300	-	-	67,800	274,300	67,800
Subtotal	505,000	559,400	285,100	228,600	296,400	788,000	581,500
2. Regional							
(a) Flood control	-	7,600	7,600	24,200	24,200	31,800	31,800
(b) Local economic developments	464,700	464,700	-	-	89,500	464,700	89,500
Subtotal	464,700	472,300	7,600	24,200	113,700	496,500	121,300
3. Total accumulative benefits	969,700	1,031,700	292,700	252,800	410,100	1,284,500	702,800
B. Costs ($)							
1. Project costs	8,044,500	7,964,200	1,511,100	1,692,700	2,527,600	9,656,900	4,038,700
2. Annual charges							
(a) Interest & amortization	272,600	269,800	51,200	57,400	85,600	327,200	136,800
(b) Operation & maintenance	82,900	79,400	25,100	5,600	61,200	85,000	86,300
(c) Total	355,500	349,200	76,300	63,000	146,800	412,200	223,100
C. Excess of beneifts over costs ($)							
1. National	149,500	210,200	208,800	165,600	149,600	375,800*	358,400
2. National and regional	614,200	682,500	216,400	189,800	263,300	872,300	479,700

Group A includes: 15-1A; 15-2A; 15-3A w/o Rec; 15-5; 15-6; 15-7; 15-9; 15-10; 15-11; 15-13A; 15-14; 15-15

Group B Same as Group A except 15-3A w/Rec

* Best combination of reservoirs to meet that portion of the local area and basin needs within the watershed.

33. ECONOMIC EVALUATION OF BASELINE PLAN

a. General. Since the time when the baseline plan for the 10 watersheds was identified, costed and the economic feasibility determined, the Water Resources Council has requested that the information be updated. This involved: (1) a recomputation of the individual project costs reflecting July 1970 rather than July 1967 price levels; and (2) that the benefits and economic justification be reevaluated using the Federal interest rate for fiscal year 1971 of 5-1/8 percent as compared to the previous rate of 3-1/4 percent. The updated benefits creditable to the individual projects studied, and the revised project costs and economic justification are summated in the following paragraphs.

b. Benefits.

(1) General. The tangible benefits creditable to the selected reservoirs and channel improvements were based on the services or functions provided by those projects, either as part of a system, or on an individual basis. In order to facilitate the evaluation, a differentiation was made between those needs that had either national or regional significance. The needs in the first category would contribute to the nation's economic development by increasing the value of the nation's output of goods and services, thereby improving the national economic efficiency and social well-being. Thus, the accruable benefits reflect the measure of monetary return to the user and/or increased value in resource utilization. The second category of benefits represents the incremental enhancement to the region's socio-economic structure that results from the investments or services provided to achieve the national objectives. By definition, the value represents an additional return that would accrue to the study area once commitments for the basic resource developments are achieved. In each case, only the net worth was derived, being computed as equivalent to the creditable gross value less any associated cost incurred in the realization of these benefits. Based on the need evaluation, the benefits potentially creditable to the projects proposed for development were confined to the satisfaction of needs associated with agricultural enhancement; specifically, flood damage reduction in the bottom lands and drainage of selected wet lands; low-flow augmentation for improving stream quality and providing a minimum base flow where conditions so warrant; general recreational developments required to satisfy the unmet demands for water-related activities; and the need to further the governmental efforts in redeveloping the region's economic structure. Benefits expected to accrue at varying rates in the future have been discounted to the base year, 1980, and distributed as an average annual value over a hundred year period. The current Federal interest rate of 5-1/8 percent was used to discount to the present worth.

(2) National benefits. Benedits creditable to the dual service system of floodwater retarding structures and channel improvements were equivalent to the worth of flood damages prevented and increased returns. The increased returns will accrue from both a projected change in the existing land-use pattern and more intensive use from presently farmed acreage. Total flood control benefits creditable to the 10 watershed systems are estimated at $3,236,600 annually. Of this amount, $1,343,400 is the estimate of flood damages prevented and $1,893,200 the worth of expected increased returns. Reflective of the objective to enhance the agricultural industry is the fact that approximately 58 percent of the total flood control benefits represent the increased value in production capacity attainable with installation of the hydraulic control systems. Drainage benefits creditable to the dual service system are estimated to average $1,008,400 annually. The gross benefits were first determined as equivalent to the increased value of improved crop patterns and production efficiencies and then discounted for delay in attainment and for less than full participation. These benefits were further reduced to account for the non-project costs associated with drainage improvements. Where storage supplementing natural flows in the interest of water quality control was provided, benefits were based on the cost of the most likely alternative in lieu of the type of service (dilution flows) under consideration for meeting this need. As was previously established, advance waste treatment was selected as the equivalent measure of worth for all load point centers, except West Frankfort where the most likely alternative was to pump the waste effluent to the Big Muddy. The annual cost of meeting these needs was evaluated, using phased increments of development with the values based on a 8-1/4 percent non-Federal interest rate, amortized over a period of 25 years, and converted to a uniform annual series for the period equivalent to the project's economic life, using the Federal rate of 5-1/8 percent. Average annual benefits attributable to the reservoirs providing supplemental low flows for water quality control at the five load points are $1,072,100 annually. In the Crab Orchard Watershed, benefits for maintaining a minimum flow were based on the cost of a single-purpose reservoir. The annual cost of meeting this need was evaluated, using time-phased increments of development with discounted value based on the Federal interest rate of 5-1/8 percent amortized over a period of 100 years. Average annual benefits attributable to maintenance of a minimum base flow are $526,700 annually. Total low-flow supplemental benefits are estimated at $1,598,000 annually. The general recreational benefits were computed as equivalent to the projected user-day needs multiplied by the unit value of the recreational activities. Comparison of the projected demands to existing and potential supplies had indicated an unmet need of some 2,000,000 recreational-days by 1980; 5,200,000 by the year 2000; and 8,400,000 by the year 2020. The monetary unit value of benefits per recreation-day would range from $0.75 to $1.50, dependent upon whether the opportunities are provided by rehabilitated strip-mine areas, reservoir construction, or environmental stream corridor development.

If it is assumed that the bulk demands would be satisfied by a reservoir program as implied by the amount of water surface required to meet these needs, 26,000 acres in 2020, the unit value of $1.00 would be applicable. Accordingly, the total discounted recreational benefits (2020 needs) are estimated at $4,875,600 annually, of which 41 percent or $2,000,000 are creditable to the 1980 initial needs.

(3) Regional benefits. As previously indicated, developments, particularly reservoirs, required to satisfy those needs listed in the national category, will serve as catalysts for additional investment in the basin. These projects will induce investments to be made that will further stimulate the area's present depressed economy, primarily by broadening its economic base and thereby raising the level of income. To quantify this induced impact, differentiation was made between those benefits that would accrue from expansion of the economic base structure and those that reflect a direct increase in income resulting from improved agricultural efficiencies. The anticipated expansion in the economic base structure was quantified by determining the change in personal income directly attributable to future water-related developments. Any growth resulting from other public and private investments was specifically excluded. The net local economic development benefits are estimated at $13,400,000 annually. The induced returns resulting from improved agricultural efficiencies were based on the expected rise in capital outlays which would be made to attain the projected productivity. The increased expenditures in turn will contribute to the growth in local agricultural-related businesses. The value of this benefit is estimated at approximately 10 percent of the increased economic returns creditable to installation of the flood control and drainage improvements or $424,500 annually.

(4) Summary of benefits. Total average annual benefits creditable to the 10 watersheds are estimated at $24,543,900. A breakdown of these benefits by categories, type, and individual watershed is shown in TABLE 16. A more detailed explanation of the procedures for updating these benefits is presented in APPENDIX N, BENEFIT EVALUATION. Benefits attributable to relief of unemployment during the construction period and operation and maintenance of the project have not been included in this evaluation. These type of benefits are based on the use of unemployed or underemployed labor in those counties suffering from an adverse employment situation. The concept of employing the human resource to its optimum potential is representative of the national objective of overcoming a depressed economic situation in an area which is below the nation's economic average. Areas designated by the Department of Labor as having substantial unemployment or underemployment become eligible for assistance under the Area Redevelopment Act of 1961, as amended. Hence, utilization of the area's labor resources that are unemployed or underemployed are valid benefits which are creditable to a project as provided by Senate Document No. 97. As of November 1970, only two of the basin's five counties are classified as being eligible

TABLE M-16
Summary of Average Annual Benefits (Dollars)1/

		National Benefits										Regional Benefits		
		Flood Control												
	Watershed	Existing Development	Future Development	Restoration of Productivity	Changed Land Use	More Intensive Land Use	Total Flood Control	Drainage	Low-Flow Augmentation	General Recreation2/	Total National Benefits	Local Economic Development	Agricultural Related Regional	Total National and Regional
5	Galum Creek	72,300	15,200	37,300	56,600	65,700	247,100	64,100			311,200		31,100	342,300
6	Upper Beaucoup	174,200	36,800	84,100	61,200	154,500	510,800	147,300	164,200		822,300		65,900	888,200
7A	Upper Crab Orchard Cr	41,800	8,800	24,300	47,800	62,500	185,200	62,100	231,400		478,700		24,700	503,400
7B	Lower Crab Orchard Cr								526,700		526,700			526,700
8	Little Muddy River	149,500	31,600	64,900	32,800	160,900	439,700	147,300	265,800		852,800		58,800	911,600
10	Hurricane Creek	6,100	1,400	11,800	5,200	14,900	39,400	14,300			53,700		5,300	59,000
11	Lake and Pond Creeks	24,100	5,100	37,400	13,200	54,400	134,200	53,300			187,500		18,700	206,200
12	Middle Fork Creek	190,200	40,400	64,600	52,400	175,700	523,300	164,100	80,900		768,300		68,700	837,000
13	Gum Creek	30,800	6,700	21,400	2,900	37,000	98,800	36,500			135,300		13,600	148,900
14	Upper Big Muddy River	298,600	63,000	104,800	29,700	217,200	713,300	212,100			925,400		92,500	1,017,900
15	Casey Fork Creek	121,300	25,500	73,700	12,000	112,300	344,800	107,300	329,800		781,900		45,200	827,100
	TOTAL WATERSHED	1,108,900	234,500	524,300	313,800	1,055,100	3,236,600	1,008,400	1,598,800		5,843,800		424,500	6,628,300
	TOTAL BASIN									4,875,600 3/	4,875,600	13,400,000		18,275,600
	TOTAL WATERSHED AND BASIN BENEFITS	1,108,900	234,500	524,300	313,800	1,055,100	3,236,600	1,008,400	1,598,800	4,875,600 3/	10,719,400	13,400,000	424,500	24,543,900

1/ Reflects a Federal interest rate of 5 1/8 percent.
2/ These types of benefits are not creditable to individual watershed since they are based on the needs of the whole basin.
3/ Estimates of benefits have been based on the unit value per recreation day of $1.00 which is representative of the worth for reservoir related usage. Final worth will be dependent upon allocation of projected needs creditable to usage of the stream corridors which have a unit value of $1.50 per recreation day.

for assistance under Title I and IV of the Redevelopment Act. This is an improvement in the area's economic situation which indicates a reversal of past trends and reflects the success of governmental and local programs. It is anticipated that by the time work on the early action program is initiated, the unemployment situation should decline sufficiently to preclude these counties from being classified as eligible for assistance under the Area Redevelopment Act. Based on this forecast, benefits in this particular category, equivalent to $581,600, were not utilized in either project formulation or economic evaluation. This decision was predicated on the expectation that these benefits would not be applicable by the time project construction is initiated.

c. Project costs. The cost of each project was updated by the agency which proposed and designed the improvement. Included were estimates for all line items of construction work and allowances for such factors as contingencies, engineering and design, supervision and inspection, and land acquisition. Installation of the recreational facilities was phased in relation to the immediate and long-range needs. The time-phasing of these developments was based on the size of the reservoir involved and its proximity to the main growth centers of the basin. The initial costs for recreational development were based on analyses of existing reservoirs and are representative of an initial level of development reasonable of attainment and acceptable to the State of Illinois for this stage of coordinating planning effort. While no firm commitment as to the extent and timing of future non-Federal investments was received, a tentative phasing of future use and installation costs was establish for each of the reservoirs considered for recreational development. Listed in TABLE 17 are the revised costs for those projects containe in the baseline plan. Of the 71 reservoirs contained therein, five are considered appropriate for construction by the Corps of Engineer and the remaining 66 by the Soil Conservation Service. These projec are over and above the plan of improvement already prepared for the Cedar Creek Watersheds.

d. Benefit-to-cost ratio. One of the basic criteria in determining a project's eligibility for authorization and ultimate construction is its economic feasibility. To determine the economic justification of the scale of development (baseline plan) under study, estimates of project cost were converted into average annual financial charges and then compared to the accruing benefits. The average annual charges include the interest and amortization equivalent of the total project cost and the applicable annual operation, maintenance, and replacement costs. Interest and amortization costs were derived, using the current 5-1/8 percent Federal rate. Both th reservoirs and channel improvements were estimated to have a hundred year economic life. In determining the benefits creditable to the particular project or group of projects under evaluation, appropriat adjustments were made to the system benefits for flood control and

TABLE M-17

Summary of base plan

		Reservoir			Channel improvements						Cost of land treatment measures ($)	Grand total ($)
					Main stem		Lateral & sublateral		Total			
	Res. No.	SCS (P.L. 566) first cost ($)	Corps first cost ($)	Total watershed cost ($)	miles	cost ($)	miles	cost ($)	miles	cost ($)		
No. 5 Galum Creek	5-1	241,000										
	5-3A	240,000										
	5-4	396,000										
	5-6	423,000										
	5-7	219,000										
	5-10	270,000										
	5-11	132,000										
	5-12	722,000										
Total for Watershed		2,643,000		2,643,000	21.6	905,000	47.8	649,000	69.4	1,554,000	3,980,000	8,177,000
No. 6 Upper Beaucoup	6-8	163,000										
	6-9	198,000										
	6-10	228,000										
	6-11	427,000										
	6-13	619,000										
	6-14	218,000										
	6-15	209,000										
	6-16	149,000										
	6-17	561,000										
	6-18A	250,000										
	C-34	--	20,000,000									
Total for Watershed		3,022,000	20,000,000	23,022,000	66.9	2,759,000	102.7	1,550,000	169.6	4,309,000	7,680,000	35,011,000
No. 7 Crab Orchard	7-6	183,000										
	7-7	2,794,000										
	7-8A	248,000										
	C-16A	--	12,000,000									
Total for Watershed		3,225,000	12,000,000	15,225,000	9.8	490,000	99.0	1,272,000	108.8	1,762,000	2,810,000	19,797,000
No. 8 Little Muddy	8-1B	224,000										
	8-9A	150,000										
	8-10	559,000										
	C-35	--	28,500,000									
Total for Watershed		933,000	28,500,000	29,433,000							7,100,000	36,533,000
No. 10 Hurricane Creek	10-1	205,000										
Total for Watershed		205,000		205,000	6.7	285,000	28.1	270,000	34.8	555,000	320,000	1,080,000
No. 11 Lake and Pond	11-2	110,000										
	11-3	695,000										
Total for Watershed		805,000		805,000	28.5	1,554,000	83.7	1,167,000	112.2	2,721,000	1,360,000	4,886,000
No. 12 Middle Fork Creek	12-1	851,000										
	12-3	245,000										
	12-4	124,000										

	12-5B	176,000										
	12-6A	255,000										
	12-7A	285,000										
	12-11	108,000										
	12-12A	258,000										
	12-13	425,000										
	C-7	--	20,600,000									
Total for Watershed		2,906,000	20,600,000	23,506,000	47.8	3,491,000	162.8	2,111,000	210.6	5,602,000	3,110,000	32,218,000

TABLE M-17 (cont'd)

Summary of base plan

		Reservoir			Channel improvements						Cost of Land treatment measures ($)	Grand total ($)
					Main stem		Lateral & sublateral		Total			
	Res. No.	SCS (P.L. 566) first cost ($)	Corps first cost ($)	Total watershed cost ($)	miles	cost ($)	miles	cost ($)	miles	cost ($)		
No. 13 Gun Creek	13-1	200,000										
	13-2	185,000										
	13-3A	279,000										
	13-4	286,000										
Total for Watershed		950,000		950,000	5.9	211,000	45.8	568,000	51.7	779,000	630,000	2,359,000
No. 14 Upper Big Muddy	14-1	354,000										
	14-2	645,000										
	14-3	178,000										
	14-4	190,000										
	14-5	192,000										
	14-6	281,000										
	14-7	1,070,000										
	14-8	293,000										
	14-9A	203,000										
	14-10A	327,000										
	14-12	567,000										
	14-14	364,000										
	14-15	496,000										
Total for Watershed		5,160,000		5,160,000	44.8	1,766,000	75.5	1,578,000	120.3	3,344,000	2,990,000	11,494,000
No. 15 Casey Fork	15-1A	388,000										
	15-2A	247,000										
	15-3A	347,000										
	15-5	277,000										
	15-6	72,000										
	15-7	71,000										
	15-9	137,000										
	15-10	204,000										
	15-11	287,000										
	15-13A	405,000										
	15-14	222,000										
	15-15	209,000										
	C-5	--	12,000,000									
Total for Watershed		2,866,000	12,000,000	14,866,000	51.0	1,539,000	89.2	960,000	140.2	2,499,000	1,990,000	19,355,000
BASIN TOTALS		22,715,000	93,100,000	115,815,000	283.0	13,000,000	734.6	10,125,000	1,017.6	23,125,000	31,970,000	170,910,000

drainage. These minor modifications were necessitated by the changes in drainage area control resulting from the maximization process. Allocation of the local economic development benefits was prorated on the basis of the project's recreational usage. This parameter was considered a primary indicator of the project's value for attracting outside capital and starting the type of local growth pattern identified in quantifying this induced worth. A summary of the project cost, both first cost and annual charges, creditable benefits and applicable benefit-to-cost ratio for the projects and total system in each of the 10 watersheds are shown in TABLE 18.

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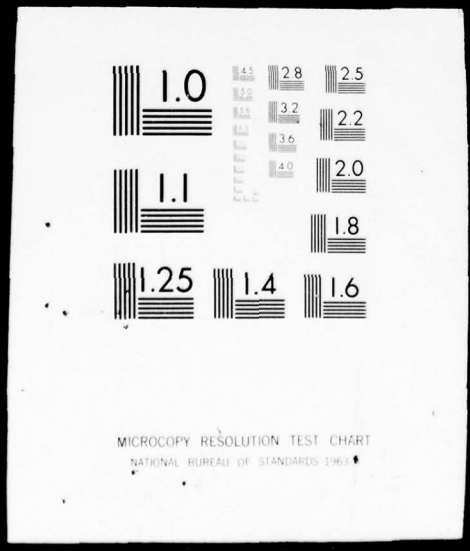

TABLE M-18

Economic evaluation, baseline plan

Watershed	Project Costs ($) First Cost	Project Costs ($) Annual Cost	Average Annual Benefits ($) National Account	Average Annual Benefits ($) National & Regional Account	Benefit-Cost Ratio National Account	Benefit-Cost Ratio National & Regional Account
No. 5 Galum Creek						
a. Corps Reservoirs						
b. SCS Projects						
(1) Reservoirs (8)	2,643,000	141,200				
(2) Channel (69.4 miles)	1,554,000	106,000				
(3) Totals	4,197,000	247,200	311,200	342,300	1.26	1.38
c. Total Watershed	4,197,000	247,200	311,200	342,300	1.26	1.38
No. 6 Upper Beaucoup						
a. Corps Reservoirs (1)	20,000,000	1,269,100	1,036,100	4,053,400	0.82	3.19
b. SCS Projects						
(1) Reservoirs (10)	3,022,000	160,900				
(2) Channel (169.6 miles)	4,309,000	294,000				
(3) Totals	7,331,000	454,900	460,700	506,700	1.01	1.11
c. Total Watershed	27,331,000	1,724,000	1,496,800	4,560,100	0.87	2.65

TABLE M-18 (cont'd)

Economic evaluation, baseline plan

Watershed	Project Costs ($) First Cost	Project Costs ($) Annual Cost	Average Annual Benefits ($) National Account	Average Annual Benefits ($) National & Regional Account	Benefit-Cost Ratio National Account	Benefit-Cost Ratio National & Regional Account
No. 7 Crab Orchard						
a. Corps Reservoirs (1)	12,000,000	699,500	706,900	1,374,200	1.01	1.96
b. SCS Projects						
(1) Reservoirs (3)	3,225,000	227,800				
(2) Channel (108.8 miles)	1,762,000	118,100				
(3) Totals	4,987,000	345,900	605,500	1,130,000	1.75	3.27
c. Total Watershed	16,987,000	1,045,400	1,312,400		1.26	
No. 8 Little Muddy						
a. Corps Reservoirs (1)	28,500,000	1,807,300	1,717,100	6,286,400	0.95	3.48
b. SCS Projects						
(1) Reservoirs (3)	933,000	49,700				
(2) Channel	-------	-------				
(3) Totals	933,000	49,700	35,200	38,700	0.71	0.78
c. Total Watershed	29,433,000	1,857,000	1,752,300	6,325,100	0.94	3.41

TABLE M-18 (cont'd)

Economic evaluation, baseline plan

Watershed	Project Costs ($) First Cost	Project Costs ($) Annual Cost	Average Annual Benefits ($) National Account	Average Annual Benefits ($) National & Regional Account	Benefit-Cost Ratio National Account	Benefit-Cost Ratio National & Regional Account
No. 10 Hurricane Creek						
a. Corps Reservoirs						
b. SCS Projects						
(1) Reservoirs (1)	205,000	11,000				
(2) Channel (34.8 miles)	555,000	39,200				
(3) Totals	760,000	50,200	53,700	59,000	1.07	1.18
c. Total Watershed	760,000	50,200	53,700	59,000	1.07	1.18
No. 11 Lake & Pond						
a. Corps Reservoirs						
b. SCS Projects						
(1) Reservoirs (2)	805,000	43,000				
(2) Channel (112.2 miles)	2,721,000	200,000				
(3) Totals	3,526,000	243,000	187,500	206,200	0.77	0.85
c. Total Watershed	3,526,000	243,000	187,500	206,200	0.77	0.85

TABLE M-18 (cont'd)

Economic evaluation, baseline plan

Watershed	Project Costs ($) First Cost	Project Costs ($) Annual Cost	Average Annual Benefits ($) National Account	Average Annual Benefits ($) National Regional Account	Benefit-Cost Ratio National Account	Benefit-Cost Ratio National & Regional Account
No. 12 Middle Fork						
a. Corps Reserovirs (1)	20,600,000	1,341,600	1,073,600	4,786,200	0.80	3.57
b. SCS Projects						
(1) Reservoirs (10)	2,906,000	155,600				
(2) Channel (210.6 miles)	5,602,000	376,000				
(3) Total	8,508,000	531,600	547,700	602,500	1.03	1.13
c. Total Watershed	29,108,000	1,873,200	1,621,300	5,388,700	0.87	2.88
No. 13 Gun Creek						
a. Corps Reservoir						
b. SCS Projects						
(1) Reservoirs (4)	950,000	50,900				
(2) Channel (51.7 miles)	779,000	53,800				
(3) Totals	1,729,000	104,700	135,300	148,900	1.29	1.42
c. Total Watershed	1,729,000	104,700	135,300	148,900	1.29	1.42

TABLE M-18 (cont'd)

Economic evaluation, baseline plan

Watershed	Project Costs ($) First Cost	Project Costs ($) Annual Cost	Average Annual Benefits ($) National Account	Average Annual Benefits ($) National & Regional Account	Benefit-Cost Ratio National Account	Benefit-Cost Ratio National & Regional Account
No. 14 Upper Big Muddy						
a. Corps Reservoir	---	---				
b. SCS Projects						
(1) Reservoirs (13)	5,160,000	276,200				
(2) Channel (120.3 miles)	3,334,000	226,800				
(3) Totals	8,494,000	503,000	925,400	1,017,900	1.84	2.02
c. Total Watershed	8,494,000	503,000	925,400	1,017,900	1.84	2.02
No. 15 Casey Fork						
a. Corps Reservoir (1)	12,000,000	724,400	696,800	1,704,700	0.96	2.35
b. SCS Projects						
(1) Reservoirs (12)	2,866,000	153,700				
(2) Channel (140.2 miles)	2,499,000	185,000				
(3) Totals	5,365,000	338,700	369,300	406,200	1.09	1.20
c. Total Watershed	17,365,000	1,063,100	1,066,100	2,110,900	1.00	1.99

SECTION VII - MODIFICATION OF THE BASELINE PLAN

34. GENERAL

While the baseline plan would satisfy most of the water- and land-related needs, it represented an economic evaluation involving only measurable benefits. Although responsive to the tangible needs, it did not include provisions for specific socio-environmental considerations. These intangibles are of sufficient import to warrant consideration for modifying, or extending, the baseline plan. In particular, planning agencies of the State and local counties had advocated the need to establish river recreational corridors and rehabilitate strip-mine areas. However, before any additional formulation was initiated, the baseline plan was analyzed to determine what particular products or services it provides that could contribute to an effective environmental control program. Low-flow augmentation would enhance the recreational value of the waterway and the land contiguous to the stream. It would also provide opportunities for development of different types of water- and land-related recreational pursuits not now readily available. Furthermore, certain acreage in the flood plain is anticipated to remain fallow, not particularly suitable for agricultural development, but with proper management, would have an effective potential for enhancing the social well-being.

35. RIVER RECREATIONAL-ENVIRONMENTAL CORRIDOR

a. Plan formulation. Possible development of selected flood plain acreage for public use has been identified as a major consideration in the environmental control of the basin. The proposal for creating public use areas along the main stems of the Big Muddy River, Little Muddy River, and Beaucoup Creek is contained in the basin counties' land-use plan. All three are suitable for development as recreational-environmental corridors, since the potential of these streams as scenic rivers will be enhanced by the flood protection and flow supplementation afforded the major portions of these streams by three Corps reservoirs: Rend Lake on the main stem; Reservoir No. 35, located on the Little Muddy east of DuQuoin; and Reservoir No. 34, located above Pinckneyville in the Upper Beaucoup Watershed. These reaches would provide an enhanced base for interrelated land and water recreational opportunities normally not provided by reservoirs. Hence, special attention was given to the establishment of river recreational corridors in each of these areas. Formulation was based on a multiple-use concept providing: (1) a greenbelt to preserve the natural environment that the residents need to insure their social well-being; (2) a basis for preserving the ecological system for the area's wildlife to offset future losses that will be incurred as the basin grows; and, (3) a base for

stream-oriented recreation. To create such a managed environment, three particular facets had to be considered: the waterway itself - its ecology and flow characteristics; the geophysical aspects of the lands which border the stream; and the type of usage compatible with the stated objectives. Essentially, the objectives of management would be the development of multi-use areas that are suitable for stream-related fishing and general recreational activities, aesthetic enjoyment, wildlife habitat, and the preservation of other natural resources, particularly those archaeological and historical sites which are river-oriented. Waterway consideration would involve the quantity and quality of stream flow and the associated flora and fauna of the contiguous land. Land management would seek a controlled intermix of agricultural development, pastures, timber, and specific cover and vegetation useful for the preservation and enhancement of the environment. The soils in the area lend themselves to this type of intermix, belonging to the Belknap-Bonnie-Karnak classification. The land has a low permeability rate with high seasonal water tables. It is slow to dry out, slippery when wet, and hard and rough when dry. While the vegetation is comparatively easily damaged when wet, the soil supports a variety of bottom land hardwood tree species native to the area.

b. Development requirements. To successfully achieve the stated objectives, it is necessary to control land on either side of the watercourse and have adequate length to assure a significant base for good management practices. Interspaced would be sites developed for specific aesthetic value and both stream fishing and general recreational opportunities. In general, the corridor would be a mix of public and private ownership, with restricted-use easements and rights for linear access obtained on acreage that is retained in private ownership. Dedication of a strip of land 1,000 feet in depth from the high bank on both sides of the stream is considered sufficient to provide a working acreage for management and action programs. However, this measurement would be varied, dependent upon the significance of the environmental and archaeological features in the different parts of the streams. Three specific corridors would be established. The first corridor would extend some 103 miles along the main stem of the Big Muddy from the Rend Lake Dam downstream to the stream's confluence with the Mississippi River. A second corridor, some 47 miles long, would be established from below the Corps Reservoir No. 35 on the Little Muddy to its confluence with the Big Muddy. A third corridor, 28 miles long, would be created in the lower portion of the Beaucoup Creek extending from the confluence of Galum Creek to the Big Muddy River. Initial development of sites for general recreational opportunities would be restricted to the corridor on the main stem of the Big Muddy River. The other two corridors would

initially be managed as a greenbelt, with emphasis on development of wildlife habitat. Controlled access or angler-use sites for stream fishing would be provided on all three. Specific landscaping with adequate buffer zones would be required to insure separation of the recreational developments from the remainder of the main stem corridor that would be retained in a natural, but controlled, environment. The general recreational facilities provided should be developed in a primitive park setting and offer selected opportunities for both day and possibly overnight usage. Location of both the fishing and general recreational sites should be planned at or near good stream road crossings. Local interests have proposed initial development of four specific areas for general recreational usage on the Big Muddy River. The first area would be located near river mile 87 and be incorporated in the acreage controlled by the West Frankfort Park District, which includes the community of West Frankfort and the village of Orient. The second site would be developed near the community of Hurst at river mile 64, where a good site with proper environment has been under consideration for park development. The third site would be located near river mile 35 and be incorporated as part of existing Murphysboro Park adjoining the stream. The fourth area would be more than just a site development; rather, it would be an extensive park and recreational development strip extending from river mile 27 to the confluence of the Big Muddy and Mississippi Rivers. Contributing to the uniqueness of this particular area is the fact that these acreages generally lie within the boundaries of the Shawnee National Forest. Acquisition and development of any private in-holdings in this area would be in consonance with that agency's plans for multiple-use and improvements. In addition, the proposed Mississippi River linear recreational corridor, the Great River Road, will traverse this same area. Both will be augmented by still another corridor, the George Rogers Clark Recreation Way, which will serve to connect recreational facilities built along the Mississippi and Ohio Rivers and which will terminate in this area. Because the forest provides the main environmental support area, it is recommended that development of this area be integrated into the Shawnee National Forest recreational plan. Each of the general recreational sites should have river frontage at least five miles long, with the acreage purchased totally in fee. Development of these recreational areas would extend to both sides of the river, with the recreational facilities concentrated in the middle one-mile zone. It is in this area that such recreational pursuits as camping, bank fishing, picnicking, boat launching and possible swimming beaches would be provided. In addition, buffer zones two miles long would be planned on either side of this center zone, separating those facilities from the rest of the recreational corridor and at the same time providing a basis for development of specific day-use and land-related activities. These day-use activities would

include hiking trails, horseback riding trails, and other related nature-oriented pursuits. The angler-use site will serve as access and stopping-off points for bank and float fishermen and hunters. Dependent upon road access, each site should have sufficient acreage to satisfy requirements for sanitation, potable water, and parking. In addition to these areas, acquisition in fee is recommended for those acreages that contain unique ecological and environmental aspects or any archaeological findings worthy of preservation and which could serve as a tourist attraction.

c. Land control. In establishing the three corridors, the counties will face the possibility of a minor reduction in the assessed land values which serve as their tax base. To partially offset this potential loss, it was recommended that the ownership of these land portions should be varied, depending upon the specific use of the reach of stream involved. As has been indicated, all lands developed for either fishing or general recreational usage should be bought in fee. This also applies to those acreages required for the preservation of archaeological artifacts or special natural environment. The rest of the land can be controlled through the use of special easements that are restrictive in nature, but at the same time, afford the owner a special inducement to insure participation. A decision will have to be made by the basin residents concerning the amount of acreage that should be acquired in developing the recreational corridors. The option of zoning some of these lands for open-space usage is an attractive supplement to total purchase in fee or use of restrictive easements. Zoning for open-space usage will permit certain acreage to remain as private holding and be developed for agricultural production. Furthermore, zoning can be supplemented by the use of scenic easements, and special, but variable, reduced tax rates to control and encourage development of a suitable environment that would include the various types of agricultural production. Easements that specify the type and amount of the cultural work undertaken by the landowner would permit the owner to receive full value from any products harvested from the land. The harvesting, be it field crop, pasture, or timber, would be governed by a management plan and would have to be compatible and be subject to the primary use requirements of that reach of stream. Care is required to insure that the land-use planning is restrictive in nature, and, at best, the crop and pasture lands should be interspersed throughout the various lengths of recreational corridor. In addition, every effort should be made to minimize any effect on drainage for the contiguous upland acreage. To enhance the environmental aspects of these corridors, planting should be concentrated in selected types of timber and vegetative cover. Manipulation of the vegetation will affect the wildlife, recognizing that wildlife is not managed; it is the habitat which is managed. Tree species, particularly of the mast or nut producers

should be encouraged. Planting should include black walnut, pin oak, and ash species, with cottonwood as a possible supplement due to the flooding characteristics of the bottom lands. Planting of early spring flowering shrubs and such tree species as dogwood and red bud should also be encouraged. This, together with selected herbaceous plants and grasses, should provide adequate ground cover to prevent soil erosion.

d. Implementation. To date, the lands encompassed by the recreational-environmental corridors have been zoned for public use in the land-use plans adopted by the counties. These plans, however, have not been implemented by necessary ordinances, nor have the economic implications that would be caused by removal of these lands from the tax rolls ascertained. Consequently, while establishment of the 178 miles of stream corridor has been incorporated into the basin plan of improvement, additional studies will be required before acquisition and development are undertaken. Since the value of the three corridors is directly related to the basic water regimen control effected by the three Corps reservoirs, development of these corridors should be phased and made part of those projects' recreational master plan. Accordingly, the Coordinating Committee selected the Corps of Engineers as the agency responsible for undertaking the necessary studies leading to Federal involvement in creating these corridors. The authorizing study with the necessary coordination should establish the design controls relative to: acreage; usage; costs, including annual charges for operation and maintenance of the various stream reaches; and the zoning, type of ownership, and adjusted tax structure needed to encourage local participation. Development and administrative arrangements probably should be similar to those of Public Law 89-72, since these projects would have a partial recreational function. Funding for implementation should be time-phased to coincide with construction of the three Corps reservoirs. Contingent upon written agreement with the State and local agencies, the Corps of Engineers should proceed to acquire all lands required for establishment of the corridors, either in fee or in easement, as identified in the authorizing and subsequent master plan. The Corps of Engineers then will offer the option to the participating agencies to cost-share the acquisition and development of the corridor lands or to reimburse the Federal Government in full and acquire land deeds subject to an agreement to administer said lands as outlined in the master plan. The management of the project-associated lands and resources located within the Shawnee National Forest will be the responsibility of the Forest Service subsequent to total acquisition and development of the master-plan facilities by the Corps of Engineers.

36. JUSTIFICATION OF THE RECREATIONAL-ENVIRONMENTAL CORRIDORS

Subsequent to defining the scope of development, the cost for establishing the three recreational-environmental corridors was determined. A combination of fee and easements was used as the basis for evaluating the cost of the lands required. Also included as part of the total project costs were such items as damages, mineral subordination, resettlement and acquisition charges, recreational and stream access facilities, and contingencies. It is presently estimated that approximately 58,000 acres would be acquired for the three corridors, of which approximately 31,000 acres or 53 percent would be in fee. This rate of fee to easement is considered preliminary and should be subject to refinement during preparation of the authorizing report. The high ratio was used to insure inclusion of those lands necessary for proper management, linear continuity, and total site development, including buffer zones. Total project costs for the three corridors are currently estimated at $15,300,000, of which $9,200,000 is for the corridor on the main stem of the Big Muddy River, $3,500,000 for the corridor on the Little Muddy River, and $2,600,000 for the lower portion of Beaucoup Creek. The tangible benefits that would accrue to these three project elements were evaluated by the Bureau of Outdoor Recreation and the Bureau of Sport Fisheries and Wildlife in cooperation with appropriate State and local planning agencies. The Bureau of Outdoor Recreation has estimated that an average annual visitation of some 200,000 user-days could be expected once the projects are in operation. Based on a unit value of $1.50 per user-day, the general recreational benefits initially creditable to the corridors would amount to $300,000 annually. Ultimate usage is expected to reach 700,000 to 1,200,000 recreational-days annually. The Bureau of Sport Fisheries and Wildlife has quantified the potential for satisfying a latent stream fishery demand. Primarily, the corrdidors will assure preservation of the stream habitat, improve fisherman access to the stream reaches, and permit a more intensive stream fishery management program. Furthermore, reservoir releases for low-flow augmentation will promote a better mix of game fishery in the streams, thereby upgrading the quality of fishing experience. As indicated in APPENDIX I, poor water quality, low fish population, and lack of access have had the combined effect of severely limiting stream fishing. Of the total fishing experienced in the five-county area, only three percent is estimated as occurring in the stream segments being proposed for corridor development. Fishing use in these three stream reaches is estimated to average some 12,600 fisherman days annually without corridor development. This is expected to increase approximately seven-fold or to 88,200 fisherman days annually when the corridors are operational. Consequently, a net increase of 75,600 fisherman days is creditable to the three corridors; and due to the greatly improved quality of the fishery, the average daily value per fisherman day is expected to increase from $0.50 to $1.50. Therefore, the total net fishery

benefits creditable to the three corridors amounts to $126,000 annually, of which $72,900 would be creditable to the corridor on the main stem of the Big Muddy; $33,300 for the corridor on the Little Muddy River; and $19,800 for that reach of stream in the Lower Beaucoup Creek. Total tangible benefits are thus equal to $426,000 annually. In addition to the foregoing, there are at least three other types of intangible benefits, excluding those associated with sites of historical significance. The first type concerns the beneficial aspects the corridor will have on the area's wildlife ecological balance. While these corridors are not expected to add to the existing supplies, the intangible value to the area's wildlife will be two-fold. Of principal import is the preservation of a varied and valuable wildlife fauna and the opportunity to harvest or otherwise enjoy it. The habitat provided by the corridors is needed to assure a continued ecological balance and diversity of wildlife species, particularly the aquatic mammals, wood ducks, and other animals dependent upon the river bottoms. Concurrently, the corridors also will insure continued and improved access to those desiring to hunt in the bottom lands. The second type of intangible benefit is one of an incidental nature concerning the streams' water quality. The induced agricultural waste load of insecticides, pesticides, and herbicides and resultant adverse effect on the streams' ecological system has been the subject of increasing national concern. Control of land use paralleling the streams and a program providing adequate cover will combine to create a natural filter bed for agricultural effluents and silt loads normally injected into the streams by surface runoff. The third type of intangible benefit concerns the commercial potential for forest production which, as an outgrowth of the planned recreational and environmental programs, will serve to encourage land owners participation. The degree of success, however, will be dependent upon the application of appropriate management techniques and use of selected timber species. In planting the vegetative cover and selecting the tree species, assistance from the U. S. Forest Service and the Soil Conservation Service will be needed to insure proper management, grading, and land treatment measures. It has been concluded that the value of these intangible benefits from either a social or environmental standpoint will, over time, exceed the cost required for implementation; and that the corridors are required to satisfy these objectives.

37. REHABILITATION OF STRIP-MINED AREAS

a. General. The effects of strip mining on the basin's land resources has been a source of considerable concern to the State and local residents. Thousands of acres have been left in an aesthetically blighted condition and are no longer economically productive. An annual report prepared by the Illinois Department

of Conservation indicated that in 1969 there were over 35,800 acres in the five core counties which have been affected by strip mining. As previously indicated, local interests have underscored the need to develop a program that would adequately restore the value of these resources. The Greater Egypt Regional Planning and Development Commission during preparation of its land-use plan identified various proposals that should be considered in the rehabilitation of these acreages. Included were such agricultural endeavors as tree farms, pasture lands or such urban uses as residential developments where feasible. Establishment of fish farms, hunting preserves, and other recreational activities were recommended as alternative possibilities.

b. Proposed improvements. These proposals were reviewed as part of the study effort responsive to both an area redevelopment and an environmental concern. While existing Illinois legislation for control of both water quality and mining are adequate to prevent undesirable effects from active and future works, the real problem involves those strip-mined areas that have been abandoned in the past. It was recognized that the main objective of any remedial program would be to restore a basic natural resource, land, to a potential for income production. By so doing, the environmental objective should automatically be achieved. Preliminary evaluations indicated that the restoration cost required for conversion to recreational usage would be comparatively less than that required for all other suggested uses. Furthermore, projections indicate that additional acreage for food and fiber production will not be required until after the year 2000; and then it would be more economical and effective to convert other lands to agricultural usage. Rehabilitation for commercial or residential usage may be a suitable alternative only if it contributes to the planned control of growth areas and urban concentrations, an implicit requirement in the adopted land-use plans. Hence, from both a need and cost standpoint, it was concluded that rehabilitation of the strip-mine areas should be designed primarily to meet the long-range recreational deficiencies, even though it would be undertaken to meet the immediate need of area redevelopment. While the general distribution of the strip-mine areas are known and the adverse effects on the basin's environmental and economic structure can be established, more detailed studies will be needed before a suitable restoration program can be adopted. Accordingly, it was recommended that the Corps of Engineers be authorized to prepare a study that would first define the strip-mine problems and then establish a program designed to restore the income potential of these areas. Participating should be all Federal, State, and local agencies known to have an interest in this matter. The remedial measures would be based on a research and engineering study of the applicable geographic, geologic, and mining conditions in each of the five counties. The report that is submitted to Congress should contain recommendations dealing with:

(1) any proposed controls and restoration measures required to achieve the environmental and socio-economic objectives; and (2) suggested areas of responsibility between Federal, State, and local governments for accomplishing and funding the recommended action program. A combined acquisition program involving both fee and easement will be needed. Where easements are considered, public control should be on a long-term lease basis. In defining the acquisition program, proper consideration should be given not only to those lands requiring restoration, but also the need for both research and administrative controls. The basic intent of the improvements should be: (1) to transform these lands with minimum investment into a habitat sufficient to support selected wildlife species; (2) to provide additional general recreational opportunities; and, (3) to contribute to the improvement of the various streams' water quality by reducing the adverse effects from sedimentation and acid runoff. Selection of specific tracts and the subsequent acquisition and development will be of long-term duration, and, of necessity, require implementation with local zoning ordinances. This restoration proposal would be in accord with both the State's recreational plan and the local land-use plan.

SECTION VIII - EVALUATION OF THE MODIFIED BASELINE PLAN

38. GENERAL

Subsequent to the selection of the baseline plan and the modifications required for socio-environmental considerations, the resultant composite was again reexamined. This reevaluation specifically sought to identify the level of need satisfaction achieved both singly and on a composite basis and to ascertain if any other changes were warranted, particularly in meeting future needs. This analysis attempted to improve both the performance standards (need satisfaction) and the plan's flexibility while identifying specific areas of concern for further implementation. There are presented in the following paragraphs discussion concerning the effectiveness achieved relative to the purposes served.

39. FLOOD CONTROL AND DRAINAGE IMPROVEMENTS

To facilitate the hydrologic and economic evaluation, the basin was divided into 15 individual watersheds. Of these, two, namely No. 2 - Cedar Creek and No. 3 - Kinkaid Creek, already had approved plans of improvement which were in various stages of development and thus were not reevaluated in this study. The investigation for agricultural enhancement had identified a maximum of 155,300 acres within the flood plains of the remaining watersheds that are inundated on an average of once every 50 years, and which had an economic potential for some degree of flood flow reduction. Also included in the 13 watersheds were some 100,360 acres of bottomland and some 189,530 acres of land outside the flood plain which required some form of drainage improvements. Preliminary studies further reduced the 13 watersheds to 10 when it was found that tributary improvements for flood control and drainage could not be economically justified in the following watersheds: No. 1 - Lower Big Muddy, and No. 9 - Central Big Muddy, both downstream of Rend Lake Dam; and No. 4 - Lower Beaucoup Creek. Thus, the final phase of investigation for agricultural enhancement involved consideration for alleviating all or portions of the flood problems on some 103,600 acres and the wetland condition of some 236,500 acres, of which 138,200 were located outside the flood plain. The recommended plan of improvement for flood control and drainage is shown on Figure 1 Included are 70 of the 71 baseline reservoirs that contain sufficient storage to control those floods having a frequency of occurrence ranging from 1 to 3 years. Shown also, are the 283 miles of main channel improvements that have been recommended

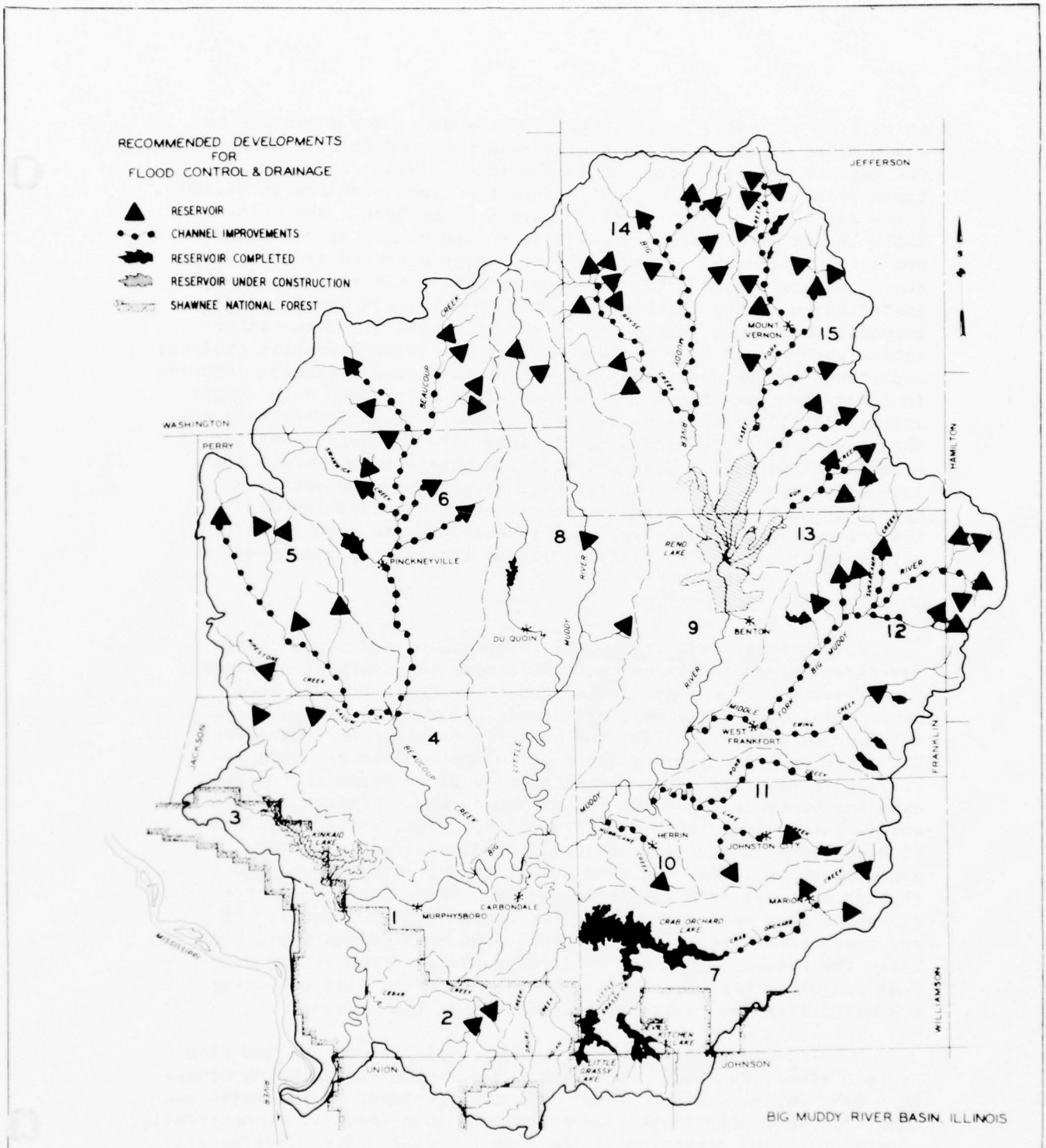

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FIGURE 1

as part of the total agricultural improvement. Not shown are the 734.6 miles of laterals and sublaterals required to help drain the wetland acreages adjacent to the flood plain. The plan of improvement as formulated will reduce the flood problems on 58,320 acres and help drain some 189,200 acres of wetland. Shown in TABLE 19 are pertinent data relative to the number of reservoirs and miles of channel improvement, and acres affected in each of the 10 watersheds. During this evaluation it was recognized that installation of the tributary channel improvements would have a comparatively minor, but adverse, effect on the flood characteristics on the main stem below Rend Lake. A joint hydraulic analysis undertaken by the construction agencies indicated a general increase in flood-flow elevations for the more frequent floods with comparatively little effect for the rarer floods. Shown in TABLE 20 are the results of these hydraulic routings. Furthermore, damaging effects to associated fish and wildlife populations through the loss of stream and land habitat will result from the enhanced agricultural program. The Bureau of Sport Fisheries and Wildlief, Department of Interior, has recommended the need for mitigation of these losses, particularly by the channel improvements.

40. LOW-FLOW AUGMENTATION

a. Initial study framework. Originally, the study of the low-flow regimen concluded that there were two types of problems in the basin. It was found that growth or urban centers have tended to locate on lateral tributaries of small drainage areas and over time water quality and quantity problems have developed. Thus, one problem involved the need to improve the stream's assimilative capacity by supplementing low flows based on the then existing State requirements for at-source waste treatment. The supplemental flows in this case would be sufficient to support fish and aquatic life, the State-identified stream use. The second problem involved a need to maintain a minimum base flow through a community's environmental area where the demands for all water uses were approaching the ultimate yield capacity of the upstream drainage area. These supplemental flows would minimize the potential hazards to local residents from vector problems and other health and social nuisances while also enhancing the aesthetics and environmental aspects of the area.

b. Interim study changes. Since completion of the low-flow regimen study, the State of Illinois has issued implementing orders that now require a higher level of waste treatment of the major communities previously identified as the key load centers. Concurrently, construction and expansion of the Rend Lake intercity pipeline also has induced additional factors that may directly affect the basin's hydraulic regimen. With the advent of intra-basin and inter-basin (export) transfer of water supplies, a change in both the tributary and main stem low-flow regimen can be expected. Consequently, the

TABLE M-19

Flood control and drainage program

Watershed	No. of Reservoirs	Sediment Flood control Storage	Channels (miles) Main	Laterals	Total	Acres Affected Flood control	Drainage*	
No. 5 Galum Creek	8	24,220	21.6	47.8	69.4	5,480	15,000	(7,000)
No. 6 Upper Beaucoup	11	42,000	66.9	102.7	169.6	7,590	28,200	(15,100)
No. 7 Crab Orchard	3	6,700	9.8	99.0	108.8	4,510	31,400	(24,200)
No. 8 Little Muddy	4	30,000	-	-	-	11,880	----	----
No. 10 Hurricane Creek	1	2,900	6.7	28.1	34.8	530	5,000	(4,100)
No. 11 Lake and Pond	2	6,200	28.5	83.7	112.2	1,770	14,800	(12,300)
No. 12 Middle Fork	11	26,600	47.8	162.8	210.6	11,360	44,600	(23,900)
No. 13 Gun Creek	4	4,000	5.9	45.8	51.7	900	7,700	(6,700)
No. 14 Upper Big Muddy	13	37,300	44.8	75.5	120.3	7,730	21,600	(11,100)
No. 15 Casey Fork Creek	13	15,800	51.0	89.2	140.2	6,570	20,900	(13,100)
	70	195,720	283.0	734.6	1,071.6	58,320	189,200	(117,500)

* Two figures are shown. The first is the total acreage affected by installation of on-farm drainage systems in conjunction with channel improvements. The second figure in ( ) is that portion of the total acreage affected that is outside the flood plain.

TABLE M-20

Changes in hydraulic profile
Main Stem, Big Muddy River 1/

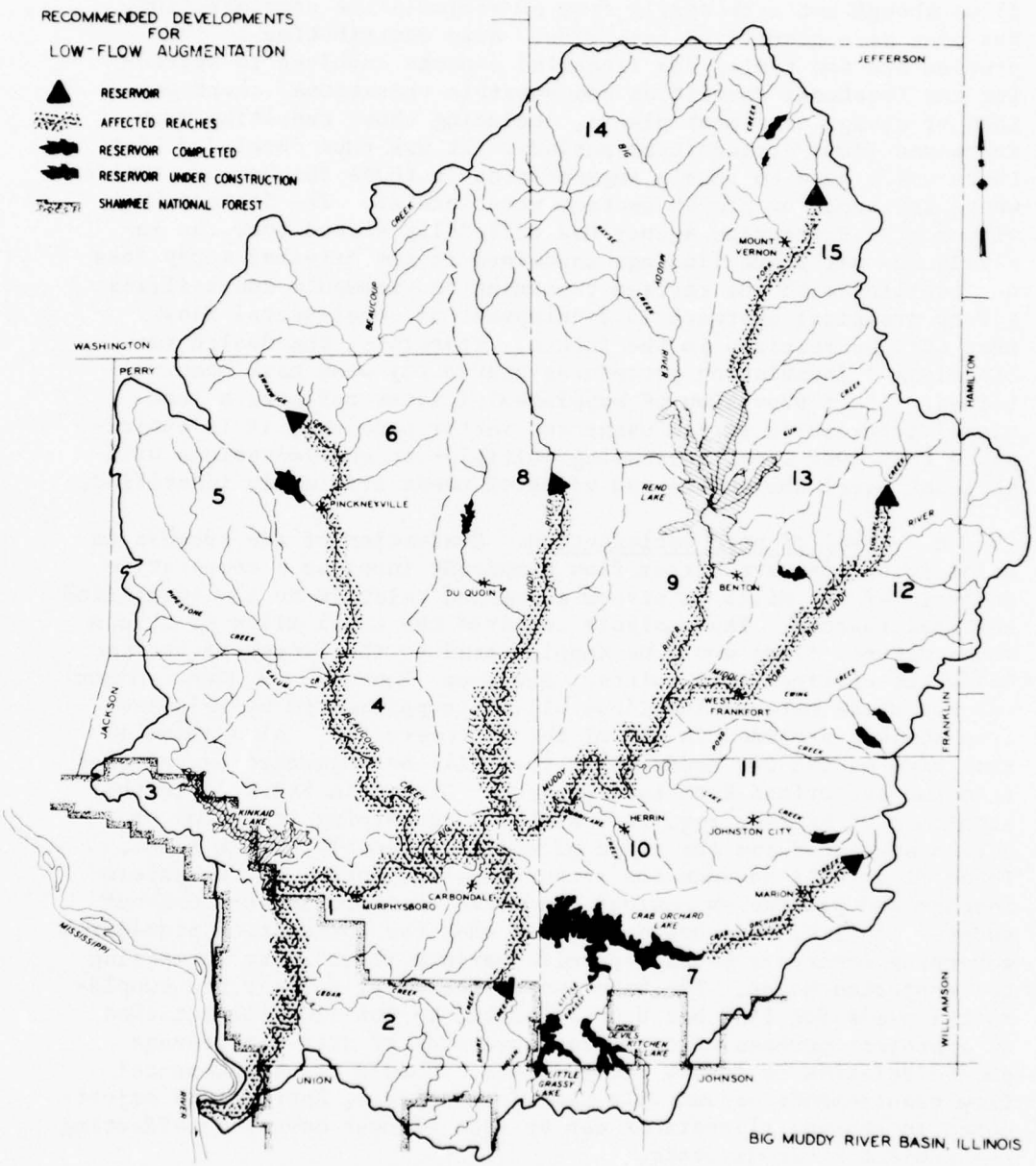
Location	Elevations (m.s.l.) for selected flood frequencies					
	2-year	3-year	5-year	10-year	20-year	50-year
Middle Fork						
Existing condition	375.3	377.9	380.8	384.8	388.3	392.5
Modified condition	378.5	380.8	383.4	386.6	389.8	393.0
Diff.	+3.2	+2.9	+2.6	+1.8	+1.5	+0.5
Hurricane Creek						
Existing condition	371.5	374.6	378.2	381.8	385.0	389.3
Modified condition	371.4	374.3	377.5	381.1	384.1	387.6
Diff.	-0.1	-0.3	-0.7	-0.7	-0.9	-1.7
Crab Orchard Creek (mi. 52.9)						
Existing condition	367.5	370.7	373.8	377.0	379.8	382.8
Modified condition	371.1	373.4	375.9	378.4	380.6	383.2
Diff.	+3.6	+2.7	+2.1	+1.4	+0.8	+0.4
Adjusted condition 2/	370.3	373.2	375.3	377.6	379.5	382.2
Diff.	+2.8	+2.5	+1.5	+0.6	+0.3	-0.6
Beaucoup Creek (mi. 42.9)						
Existing condition	367.0	370.7	373.2	375.7	377.8	380.0
Modified condition	370.8	373.0	375.0	377.2	378.9	380.8
Diff.	+3.8	+2.3	+1.8	+2.5	+1.1	+0.8
Adjusted condition 2/	369.7	372.2	374.3	376.6	378.5	380.6
Diff.	+2.7	+1.5	+1.1	+0.9	+0.7	+0.6
Murphysboro (mi. 36.5)						
Existing condition	364.3	367.1	369.3	371.4	372.8	374.5
Modified condition	367.8	369.5	371.1	372.5	373.7	375.0
Diff.	+3.5	+2.4	+1.8	+1.1	+0.9	+0.5
Adjusted condition 2/	366.8	368.9	370.5	372.2	373.5	374.8
Diff.	+2.5	+1.8	+1.2	+0.8	+0.7	+0.3

1/ Based on comparison of all-year flood frequency profiles for existing conditions with Rend Lake and the Crab Orchard reservoir complex in place and modifications caused by reservoir control and channel improvements. Profiles reflect coincidental flooding from the Mississippi River.

2/ Modified condition adjusted by deletion of channel improvements in Watershed No. 8, Little Muddy.

Federal Water Quality Administration and the State in particular have expressed the need for continued emphasis on augmenting low flows though not necessarily from an assimilative consideration, but more as a quantified base flow. Also contributing to the problem are the timing and financial aspects involved in upgrading the treatment facilities and possible operational shortcomings of sewage treatment plants, including those resulting from increased flows during storm periods. It was thus concluded that there was a need to retain augmentation in those reaches of streams where key urban or growth centers were located. The State's Environmental Protection Agency has officially stated that the analysis and resultant findings contained in the original study does not conflict with the revised treatment requirements and utilizes a very practical approach in development of supplemental flows that will be required in the future. Therefore, the design rationale and formulation procedures previously used have been retained. Since provision of supplemental flows reflects a functional interest in stream usage and vector problems, it is anticipated that over time, increasing multiple-use considerations will at least equal the volume and value of needs originally identified.

c. Level of need satisfaction. Evaluation of the success in maintaining adequate stream flow standards involved a comparative analysis of the miles of stream augmented relative to the identified critical reaches. The analysis compared the total miles of stream whose natural flows would be supplemented to the length of stream below the critical load points. Shown on Figure 2 are those stream reaches whose natural low flows will be supplemented by releases from storage provided in six of the 71 reservoirs. Also shown is that part of the Big Muddy River that will be augmented by releases from the authorized Rend Lake project. Listed in TABLE 21 is the supplemental storage required, and data concerning the miles of stream augmented and the range of modified monthly target flows. These flows will enhance the recreational potential of the stream reaches and provide an ecology conducive to improving the present species of fish. It should be noted that the formulation procedures governing reservoir storage permits maximum flexibility in meeting the projected needs. The base amount necessary to meet the supplemental needs for 1980 has been allocated to low-flow augmentation as a project purpose with future conversion of dual-use storage phased relative to future requirements. Should the supplemental flow requirements beyond this time frame change, appropriate adjustments in storage allocations can be made without adversely affecting the project's requirements.



BIG MUDDY RIVER BASIN, ILLINOIS

FIGURE 2

TABLE M-21

Low-flow augmentation program

Watershed	DO Standard	Storage Provided (acre feet)	Stream Data*		Monthly target flows (cfs)			
			Miles Augmented	Miles Below Load Point	High Flows		Low Flows	
					Initial (1980)	Ultimate (2020)	Initial (1980)	Ultimate (2020)
No. 6 Upper Beaucoup	5	6,400	60.8(55.8)	48.3(83.5)	12.0	26.0	0.54	1.2
No. 7a Lower Crab Orchard	3	19,000	21.3(15.6)	6.6(18.3)	39.0	73.0	0.95	1.6
No. 7b Upper Crab Orchard	4	4,600	44.5(14.5)	34.8(18.9)	11.0	19.0	Natural Flow	
No. 8 Little Muddy	5	18,700	47.2(47.2)	28.5(73.7)	23.0	52.0	1.10	2.30
No. 12 Middle Fork	5	20,600	32.1(25.7)	10.1(39.6)	29.0	60.0	1.30	2.7
No. 15 Casey Fork Creek	4 (w/tert.)	9,600	11.1(5.0)	5.0(23.2)	14.0	33.0	Natural Flow	

* Figures shown in (-) pertain to main stem of major tributary; and reflect miles augmented versus total length of stream (confluence with Big Muddy River to drainage area boundary).

41. RECREATION

a. Reservoirs. Of the 71 reservoirs, six have been selected for initial development in meeting the immediate general recreational needs. The six are: C-34, C-16A, 7-7, C-35, C-7, and C-5. All are multiple purpose projects and are located in five of ten watersheds studied. These six will supplement the major tourist and convention role being planned for Rend Lake by the Rend Lake Conservancy District and will help satisfy an unmet need incapable of being satisfied by the Crab Orchard complex, Kinkaid Lake, and developments planned in Cedar Creek. Also included in this initial phase of development is a modification to the recreational master plan for the Corps' Rend Lake Reservoir. Annual visitation totaling 3,000,000 user-days has been programmed for that project by upgrading selected project-associated lands to a higher use and requiring additional development of these lands for recreational usage. Even with these proposed installations, there will still be a deficiency in the long-range needs for both water surface acreage and visitation. Optimum development will meet all of the year 1980 design loads, but only 85 and 53 percent of the year 2000 and 2020 needs, respectively. With this in mind, twelve reservoirs identified by the Soil Conservation Service as having potential for multi-purpose developments, but which were recommended for development as single-purpose flood control projects initially, were then reexamined. The evaluation indicated the economic feasibility of a second-stage construction to increase storage capability in order to meet some of the long-range deficiencies that will occur after 1995. Hence, it was concluded that these twelve reservoirs initially be constructed as single-purpose flood control projects, but at such time as the needs and economic evaluations warrant, authority should be sought to enlarge these reservoirs by stage-construction and develop these projects as multi-purpose projects for both flood control and recreation. Shown in TABLE 22 are the six reservoirs recommended for initial recreational development. The optimum use potential of the six multiple-purpose projects containing storage allocations for both low-flow supplementation and recreation was determined by a separate evaluation. The expected level of optimum use was predicated on an analysis of the drawdown effects caused by releases for low-flow augmentation. The resultant water surface acreage that would be available by the year 2020 for at least 75 percent of all historical low-flow development periods was used to identify the optimum use potential and applicable development costs. Shown in TABLES 23 through 28 are the results of the drawdown studies for the five recommended Corps projects and the one SCS reservoir. According to the Bureau of Sport Fisheries and Wildlife, reservoir construction generally will support fishery of greater value than it displaces and regulating control of flows will improve the downstream fisheries, mitigating the loss of upstream habitat. Shown in TABLE 29 are the 12 reservoirs recommended for stage-construction. Shown on Figure 3 is the recreational plan recommended for initial development.

TABLE M-22

Reservoirs recommended for
initial recreational development

Watershed	Reservoir	Usable Water Surface Acres	Estimated-Usage (Average Annual) Optimum	Initial Development
No. 6 Upper Beaucoup	34	2,000	900,000	400,000
No. 7a Lower Crab Orchard	C-16A	595	200,000	150,000
No. 7b Upper Crab Orchard	7-7	430	150,000	120,000
No. 8 Little Muddy	C-35	2,700	1,360,000	680,000
No. 12 Middle Fork	C-7	2,400	1,110,000	490,000
No. 15 Casey Fork Creek	C-5	895	300,000	260,000
Subtotal		9,020	4,020,000	2,100,000
Total with Cedar Creek Developments			4,444,100	2,348,000

TABLE M-23

Availability of water surface area - percent of time
Watershed No. 6 Reservoir C-34

Water-Surface Area Joint-Use Pool* (acres)	(% Full Pool)	April 16-May 15	May 16-June 15	June 16-July 15	July 16-Aug. 15	Aug. 16-Sept. 15	Sept. 16-Oct. 15
2100	100	92	45	18	20	22	22
2058	98	100	99	79	59	47	45
2016	96		100	95	78	58	54
1974	94			98	87	78	64
1932**	92			100	89	88	81
1920***	91.4				90	90	87
1860	88.6						100

*Based on supplementation (cfs) required to maintain selected DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Mininum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-24

Availability of water surface area - percent of time
Watershed No. 7 Reservoir 7-7

Water-Surface Area Joint-Use Pool* (acres)	(% Full Pool)	April 16-May 15	May 16-June 15	June 16-July 15	July 16-Aug. 15	Aug. 16-Sept. 15	Sept. 16-Oct. 15
550	100	82	34	6	4	0	2
539	98	91	70	24	6	3	7
522.5	95	93	86	53	24	19	25
495	90	94	90	82	65	45	30
412.5	75	95	94	93	93	89	89
355**	64.5	98	96	96	95	93	93
300***	54.5						100

*Based on supplementation (cfs) required to maintain monthly DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Minimum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-25

Availability of water surface area - percent of time
Watershed No. 7 Reservoir C-16A

Water-Surface Area Joint-Use Pool*		April 16-	May 16-	June 16-	July 16-	Aug. 16-	Sept. 16-
(acres)	(% Full Pool)	May 15	June 15	July 15	Aug. 15	Sept. 15	Oct. 15
700	100	88	26	12	0	0	0
686	98	93	89	54	12	11	11
665	95	94	92	73	35	26	29
630	90	95	94	86	68	50	45
595	85	96	96	94	86	72	66
525	75	96	98	96	96	94	89
505**	72.1	98	98	97	97	95	92
250***	35.7						100

*Based on supplementation (cfs) required to maintain selected DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Minimum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-26

Availability of water surface area - percent of time
Watershed No. 8 Reservoir C-35

Water-Surface Area Joint-Use Pool* (acres)	(% Full Pool)	April 16-May 15	May 16-June 15	June 16-July 15	July 16-Aug. 15	Aug. 16-Sept. 15	Sept. 16-Oct. 15
3000	100	80	18	2	0	0	0
2940	98	94	82	44	13	15	10
2850	95	94	95	69	40	24	20
2700	90	94	94	88	80	63	35
2550**	85	95	94	90	89	83	77
2400***	80	96	94	94	93	92	90
2375	79.2	96	94	95	94	93	91
2150	71.7						100

*Based on supplementation (cfs) required to maintain selected DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Minimum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-27

Availability of water surface area - percent of time
Watershed No. 12 Reservoir C-7

Water-Surface Area Joint-Use Pool* (acres)	(% Full Pool)	April 16-May 15	May 16-June 15	June 16-July 15	July 16-Aug. 15	Aug. 16-Sept. 15	Sept. 16-Oct. 15
2700	100	74	14	2	2	0	0
2646	98	87	52	17	5	2	2
2565	95	94	90	68	35	27	16
2430	90	97	95	91	77	66	51
2295	85	98	96.5	95	89.5	84	76
2130**	78.8	99	97.5	96	94	92.5	84
1980***	73.3						100

*Based on supplementation (cfs) required to maintain selected DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Minimum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-28

Availabilitv of water surface area - percent of time
Watershed No. 15 Reservoir C-5

Water-Surface Area Joint-Use Pool* (acres)	(% Full Pool)	April 16-May 15	May 16-June 15	June 16-July 15	July 16-Aug. 15	Aug. 16-Sept. 15	Sept. 16-Oct. 15
1040	100	78	28	4	6	4	6
1019	98	92	87	35	8	10	10
988	95	93.5	90	77	45	27	26
936	90	96	94	93	76	60	45
884	85	97.5	96.5	95	93	84	84
840**	81	99	97.5	96	95	88	91.5
760***	73						100

*Based on supplementation (cfs) required to maintain selected DO standard and the applicable monthly target flows established by FWPCA for downstream control point.

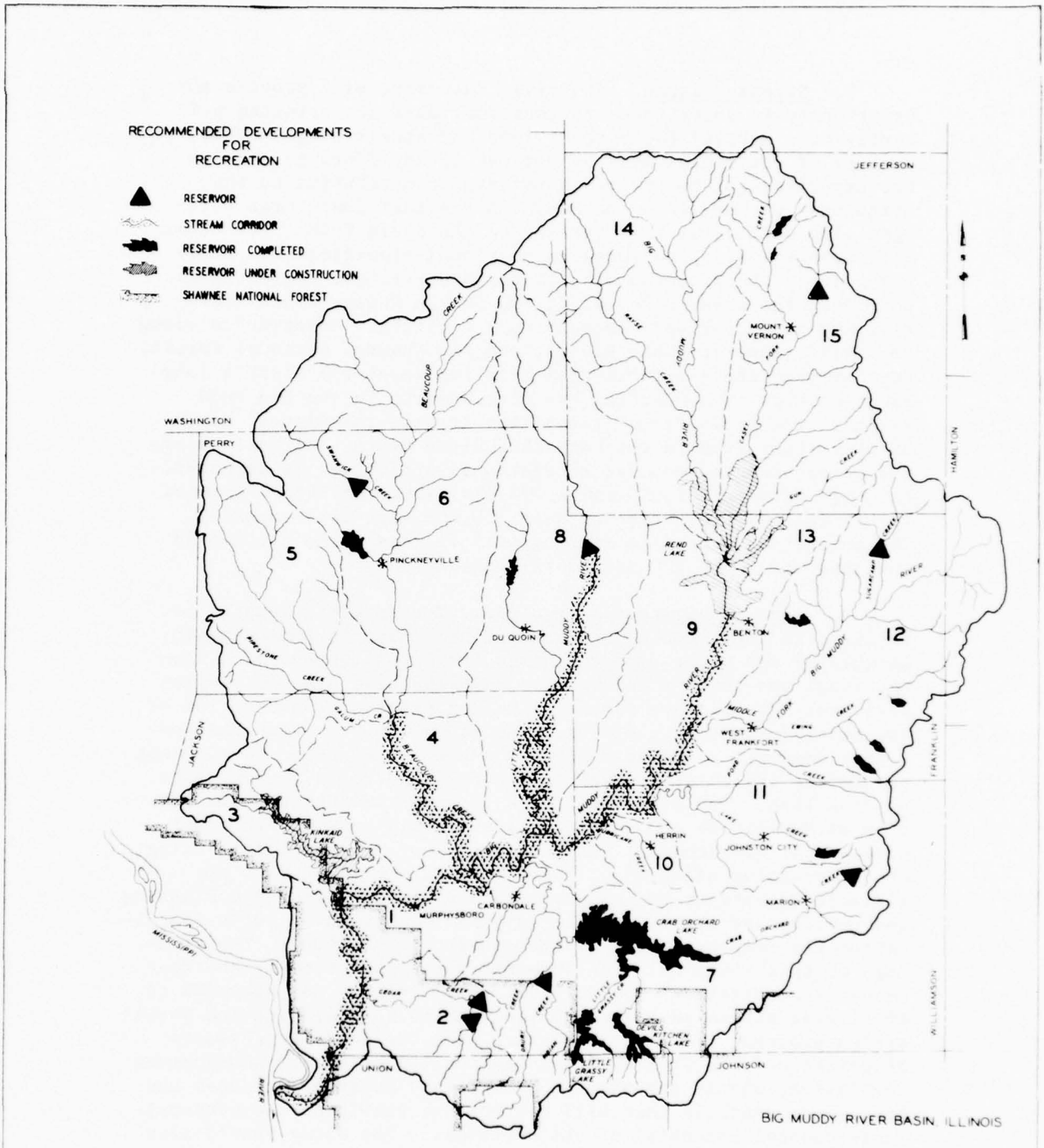
**Represents minimum acreage available after augmenting natural flows for 95 percent of all low-flow events.

***Minimum 1-day pool area (excluding evaporation) for the critical period in the 50-years of record.

TABLE M-29

Reservoirs recommended for staged recreational development

Watershed	Reservoir	Storage increment (ac-ft)	Water surface area (acres)	Creditable visitation (optimum)
No. 5 Galum Creek	5-7	7,800	650	200,000
No. 6 Upper Beaucoup	6-11	4,200	485	150,000
	6-18A	6,600	605	200,000
No. 7 Upper Crab Orchard	7-8A	5,600	520	150,000
No. 8 Little Muddy	8-10	4,200	675	250,000
No. 10 Hurricane Creek	10-1	11,600	760	250,000
No. 12 Middle Fork	12-1	17,000	1,600	680,000
	12-3	3,100	145	50,000
No. 14 Upper Big Muddy	14-6	7,400	380	100,000
	14-7	12,900	1,050	420,000
	14-12	18,000	930	300,000
No. 15 Casey Fork Creek	15-3A	4,600	260	100,000
TOTAL		103,000	8,060	2,850,000



BIG MUDDY RIVER BASIN, ILLINOIS

FIGURE 3

b. Stream-related. The river corridors will provide the opportunity to enjoy those recreational pursuits oriented primarily to a natural (primitive) land and stream usage. Thus, a variety of activities will be offered in an effort to enhance the experience of the recreationalist. Contributing to the uniqueness of the linear parkways is the fact that these acreages also will serve as a gateway to the basin from three other developments having national recreational significance. These three are: the proposed Mississippi River linear recreational corridor, the Great River Road; the George Rogers Clark Recreation Way which connects recreational facilities constructed along the Mississippi and Ohio Rivers; and the Shawnee National Forest. Furthermore, the corridors will help implement the State's long-range program of connecting the developments in the Big Muddy Basin to the recreational facilities located immediately north of this study area in the Kaskaskia River Basin. Ultimate usage for stream-related general recreational activities is expected to range between 700,000 and 1,200,000, with facilities planned for an initial visitation of some 200,000 user-days annually. The potential for stream fishing will increase some seven-fold and approximate 88,200 user-days annually.

c. Additional studies required. Two specific studies are required in implementing the recreational plan of improvement. Because of the major emphasis given the establishment of a recreational and tourism industry, a comprehensive plan for basin-wide recreational development is needed prior to construction of the multiple-purpose projects. The study would provide the necessary in-depth planning needed to achieve the proper development and define the relationships of the new reservoirs as satellite to Rend Lake. The plan would seek to avoid unwarranted duplication of facilities and services; insure site compatibility and adequacy of development; and establish a proper basis for zoning the surrounding off-project lands. It is essential that the Illinois Department of Conservation and the Greater Egypt Planning and Development Commission participate in this study, with coordination the responsibility of the construction agency. The findings of this study will be the basis for preparation of the reservoir's recreational master plan. The second study pertains to the linear stream parkways. Subsequent to establishing the acquisition program, the State, together with the local conservancy districts and the Greater Egypt Regional Planning and Development Commission, should implement the necessary zoning ordinances and stream-use controls that will protect the resultant recreational-environmental potential of the corridors. The study should also designate which legal entity(s) is to operate and maintain the corridors and create a long-range program for expanding public-use potential afforded by the corridors. This latter phase can and should be a long-range commitment that would be time-phased in conjunction with the developments planned in and adjacent to the basin.

42. AREA REDEVELOPMENT

a. General. The basic indices of population, employment, and personal income all depict the fact that the basin's socio-economic structure has been consistently below the national average in every decade since 1930. Since the early 1960's, the area has received assistance under the Area Redevelopment Act and other similar programs. A rehabilitation of the total economic base is slowly being achieved by the infusion of various types of Federal and State aid programs, a significant portion of which provide planning and construction assistance. Notable examples of the latter type include Kinkaid Lake and the water-related developments of Rend Lake, the construction of which had area redevelopment as a primary project purpose. The resulting effects have been to stem out-migration from the region and stabilize the basin's economy at a somewhat higher level, although still below the national average. The induced economic impact from these programs has been most noticeable in the growth of the area's economic wealth as measured by bank deposits, but the level of personal income is still below that of the national average. This means that for the first time, an effective base has been achieved and that future aid programs will have a greater impact in upgrading the economic structure. The impact on the reorientation of the basin's economic structure creditable to the planning and construction programs currently underway will extend through the decade 1970-1980. Those developments in the modified baseline plan which are subsequently authorized for implementation as an early action program are expected to have their major impact on the area's economic structure during the 1980-1990 period. The economic stimulus that would be achieved during this latter time frame would include an extension of the tourism and recreational industry, the base of which was established by Rend Lake, Kinkaid Lake, and the Crab Orchard Complex; increased residential, commercial, and industrial development; and, local government investments in new and expanded service facilities. These types of induced developments will not only assist in the continuation of the planned economic growth, but will provide a greater employment potential by encouraging a new, diversified, and higher paying job structure. It is through this logical progression of redevelopment assistance that the area's economic structure will ultimately achieve parity with the nation.

b. Additional planning requirements. During the course of the plan formulation studies, it was recognized that there are certain aspects that could easily alter evolution of the basin's development and cause substantial long-run deviations from the projected population and economic growth. These factors specifically involve the basin's available labor supply and its present industrial mix. The entire southern Illinois labor market is presently dominated by unskilled and semi-skilled labor and this basin is no exception. If the projected industrial turnabout is to be achieved, a change in

the labor market will be required, with major emphasis given the establishment of training programs to upgrade the present labor skills. Area training centers will be needed and should be sponsored by the three local educational institutions, Southern Illinois University and the Rend Lake and John A. Logan Junior Colleges. The five counties must collectively strive to attract those industries that will improve the area's economic base and then correlate the labor needs with the training programs. Then, as full employment is achieved, there will be a demand for developing additional local services to meet those induced needs. This will contribute to a more self-sustaining economy and improve the job and allied income flow. Concurrently, the five counties must also update their land-use plan and provide the necessary modifications needed to realize the economic potential offered by the proposed developments. Of equal importance is the need to consolidate the governmental services at the local level, doing away with the many separate political entities that are now alined on a narrow functional basis.

c. Results of evaluation. Within the context of area redevelopment, emphasis was placed on expanding the present economic base and improving the farmers income standing through increased agricultural efficiencies. If the identified level of known needs were to be fully met, the net tangible benefits creditable to the required plan of improvement (structural and nonstructural) would average $24,844,400 annually. Of this amount, approximately 44 percent are classified as national benefits and include the measureable monetary return expected from the programs for flood control, drainage, low-flow augmentation, enhanced stream fishing and general recreation. These benefits are reflective of the increased value in the nation's output of goods and services and thus represent the incremental improvement in the national economic efficiency. The remaining benefits, some 56 percent, are essentially regional in nature and will result from the continued reorientation of the basin's economy induced by the stimulus of the recommended water-related projects. Besides these quantifiable values, other intangible benefits will accompany the economic growth; the out-migration pattern of the basin will be reversed and should help alleviate the population pressures that otherwise would be exerted on nearby metropolitan areas; and, the regional economy, particularly the key service areas will benefit from the increased demands for goods. It is anticipated when once the overall plan of improvement is implemented, the basin's economy will approximate parity with the nation, now estimated to occur somewhere around the year 2030.

43. ENVIRONMENTAL QUALITY

Within the multi-objective framework, emphasis was given the need to enhance the quality of the basin's environment. The resultant nonstructural program involved an intermix of development, conservation, and restoration proposals concerning selected portions of the area's natural and cultural resources and ecological systems. The major components were concentrated in the river bottoms where the greatest returns could be effected. Development of the three linear corridors was designed to minimize or avoid future irreversible losses to the environmental base. Aside from the recreational enhancement, the acquisition and management program for the corridors will provide the basis for the conservation of wildlife habitat and preservation of those sites having archaeological, historical, or natural aesthetic values. Studies to reverse the aesthetic blight caused by abandoned strip mines have been recommended with restoration of these lands for recreation and conservation uses as the ultimate objective. Concurrently, better land management, implementation of zoning ordinances, and land treatment measures have also been included as part of the plan of improvement. These proposals will have a beneficial effect on the total stream and land ecosystems and help safeguard the natural and cultural resources. Care was taken to avoid irretrievable commitments in resource use, sacrificing environmental values at the expense of strictly economic gains. In certain cases, the concept to trade-offs was used to incure a balance in objectives, as example, replacing channel improvement in the lower portion of Little Muddy River with a linear corridor as part of the total system within that watershed. In addition to these positive proposals, a preliminary evaluation was made of the effects that the proposed structural improvements would have on the environment of the basin, particularly the fish and wildlife aspects. The Bureau of Sport Fisheries and Wildlife has indicated that in general, a reservoir will support a warm water fishery of greater value than the stream fishery it displaces. Only limited stream fishing now exists due to lack of access and unsuccessful reproduction of game fish induced by the heavy silt loads. Hence, the loss of stream acreage or mileage will not be significant due to poor water quality and limited fish population. In fact, reservoir development should create a net beneficial effect on the remaining stream fisheries, primarily through better regulation of flows and improvement of water quality and quantity. This improvement in downstream fishery generally will mitigate the loss of upstream fish habitats, particularly where a sustained flow of good quality and quantity of water is expected to improve the aquatic habitat. The adverse effects on the stream's ecological system caused by the major channel modifications will require mitigation measures. While such measures can not be specifically defined until channel design is completed, minimum compensations would involve bank stabilization, oxbow development, fencing, and the use of rip-rap, gabions, or other devices to create pools

and riffles. Both the reservoirs and the channel improvements will displace or otherwise harm resident species of wildlife within the project areas, particularly those specifically associated with the river bottoms. Conversely, the increase in impoundment waters will benefit waterfowl production and improve waterfowl hunting. The expected losses of hunting opportunities for upland game in the flood pool areas and areas developed for waterfowl production can generally be mitigated by development and management of other project lands and waters for maximum production and utilization. While it is desirable to concentrate the necessary mitigation measures locally where the losses occur, it may be preferable to incorporate many of these into the linear corridors. This will effect a more efficient program, from both a management and production standpoint, in offsetting those wildlife losses caused by the reservoirs and channel modifications. The preliminary survey of historical and archaeological artifacts has also indicated that many of these sites can be easily integrated into the development of the linear corridors and certain reservoirs, most notably C-16A. The necessary restoration measures should be included as part of the project's recreational program. To insure proper site preservation, land acquisition guidelines have been established for each of the four types of Indian cultural remains. These guidelines are set forth in APPENDIX H, Part 1.

SECTION IX - BASIN PLAN AND EARLY ACTION PROGRAM

44. COMPOSITION OF BASIN PLAN

The overall basin plan of improvement consists of 71 reservoirs, 283 miles of main stem and 734.6 miles of lateral and sublateral channel improvement, 178 miles of linear stream corridors, installation of proper land treatment measures and the rehabilitation of abandoned strip mines. Accomplishment of these proposals will afford a proper scale of development in 10 of the tributary watersheds and meet the immediate and part of the long-range basin needs. The plan will provide: (1) accelerated watershed protection, (2) flood control based on maximum control structure release rates of from 10 to 15 c.f.s. per square mile, (3) channel improvements to further enhance agricultural productivity, (4) the necessary supplementation to maintain adequate stream quality and quantity in the major tributaries, except in the lower Crab Orchard Creek and the Lake and Pond Creek Watershed, (5) the necessary low-flow augmentation to maintain a minimum base flow where public health, aesthetic and social considerations so warrant, (6) general recreational developments to meet the immediate and future needs to the fullest practical extent, (7) preservation of wildlife environment as protection against future growth intrusion in the area's habitat and ecology, (8) continued upgrading of the basin's economic structure with particular emphasis on improving personal income and agricultural production efficiencies, and (9) enhancement of the area's environment and social well-being. Included are both structural and nonstructural improvements based on tangible and intangible considerations. Total cost for the basin plan amounts to $228,870,000 and is detailed in TABLE 30.

45. EARLY ACTION PROGRAM

a. Factors in selection. Once the basin plan had been formulated, it was then necessary to establish priorities and identify the most effective sequence of implementation. Of immediate concern was the selection of those studies and programs, structural and nonstructural, that should be considered for early action and implemented during the next 10-15 years. To assure an orderly and rational implementation, various screening factors were used that imposed an order or priority and that recognized a project's tangible contribution to both the national and regional framework of socio-economic development. There were four basic factors that were used in the selection process. One was a weighted ranking system with imput based on individual priority considerations for the major needs of recreation, agricultural enhancement, and area redevelopment. A second factor was one of a budgetary nature reflecting an intent to hold the combined Federal and State commitments to an acceptable annual funding level. For purposes of this analysis, it was concluded that the early

TABLE M-30

Summary of costs, basin plan

A. Initial Development		
1. Baseline Plan		
a. SCS Reservoirs		$ 22,715,000
b. Corps Reservoirs		93,100,000
Subtotal, Reservoir Costs		115,815,000
c. Channel Improvement		23,125,000
d. Land Treatment Measures		31,970,000
Total Baseline Plan		170,910,000
2. Recreational-Environmental Corridors		
a. Main Stem @ $9,200,000		
b. Little Muddy @ $3,500,000		
c. Lower Beaucoup @ $2,600,000	=	15,300,000
Subtotal		186,210,000
3. Cedar Creek Projects		4,052,000
Subtotal		190,262,000
B. Completion of Baseline Plan's Recreational Development (1985-1995)		
Res C-34 @ 1,375,000		
C-35 @ 1,700,000		
C-7 @ 1,550,000		
C-16A@ 175,000		
C-7 @ 105,000		
C-5 @ 132,000	=	5,037,000
C. Reservoir Staged Construction for Recreational Needs (1995-2005)		
Res 6-18A@ 2,659,000		
8-10 @ 2,969,000		
12-1 @ 6,077,000		
14-7 @ 4,327,000		
14-12@ 3,611,000	=	19,643,000

TABLE M-30 (cont'd)
Summary of costs, basin plan

D. Reservoir Staged Construction for Recreational Needs (2005-2013)

Res 5-7 @	2,964,000		
6-11 @	1,976,000		
7-8A @	2,254,000		
10-1 @	2,757,000		
12-3 @	817,000		
14-6 @	1,648,000		
15-3A@	1,512,000	=	13,928,000

Total Cost, Basin Plan of Improvement (July 1970 price level) $228,870,000

action program should cost about 40 percent of that required for the total basin plan, which, over a 15 year period, would be the equivalent of approximately $6,000,000 annually. A third factor involved considerations responsive to the regional growth center concept set forth in the adopted land-use plan and the capability and willingness of local interests to provide the necessary programs to complement the selected projects. The fourth factor was the need to insure a proper balance in development, providing those improvements primarily warranted from the intangible concerns of environmental quality and social well-being.

b. Early action program.

(1) Structural and nonstructural. A priority listing was first prepared indicating the comparative value of the structural elements in meeting the recreational, agricultural, and area redevelopment needs. Once the relative rankings were determined, a priority weighting was established and summated for each project element identified. This determined the comparative ranking of the individual structural improvements. Each of the highly ranked structures was then analyzed as to its effectiveness in meeting the immediate needs, its compatability with the growth center concept. efficiency and its contribution towards the growth center concept. The latter was important from a regional standpoint, since the growth and multiplier effects achieved would vary, particularly being influenced by location and extent of resource control. Subsequently, those nonstructural improvements responsive to the preservation, conservation, and environmental objectives were added and the early action program then balanced to stay within the specified budgetary constraint. The structural and nonstructural improvements recommended for early implementation are itemized in TABLE 31. The total first cost is estimated at $90,212,000. The basin plan and those projects recommended for initiation in the next 10 to 15 years are shown on PLATE 4.

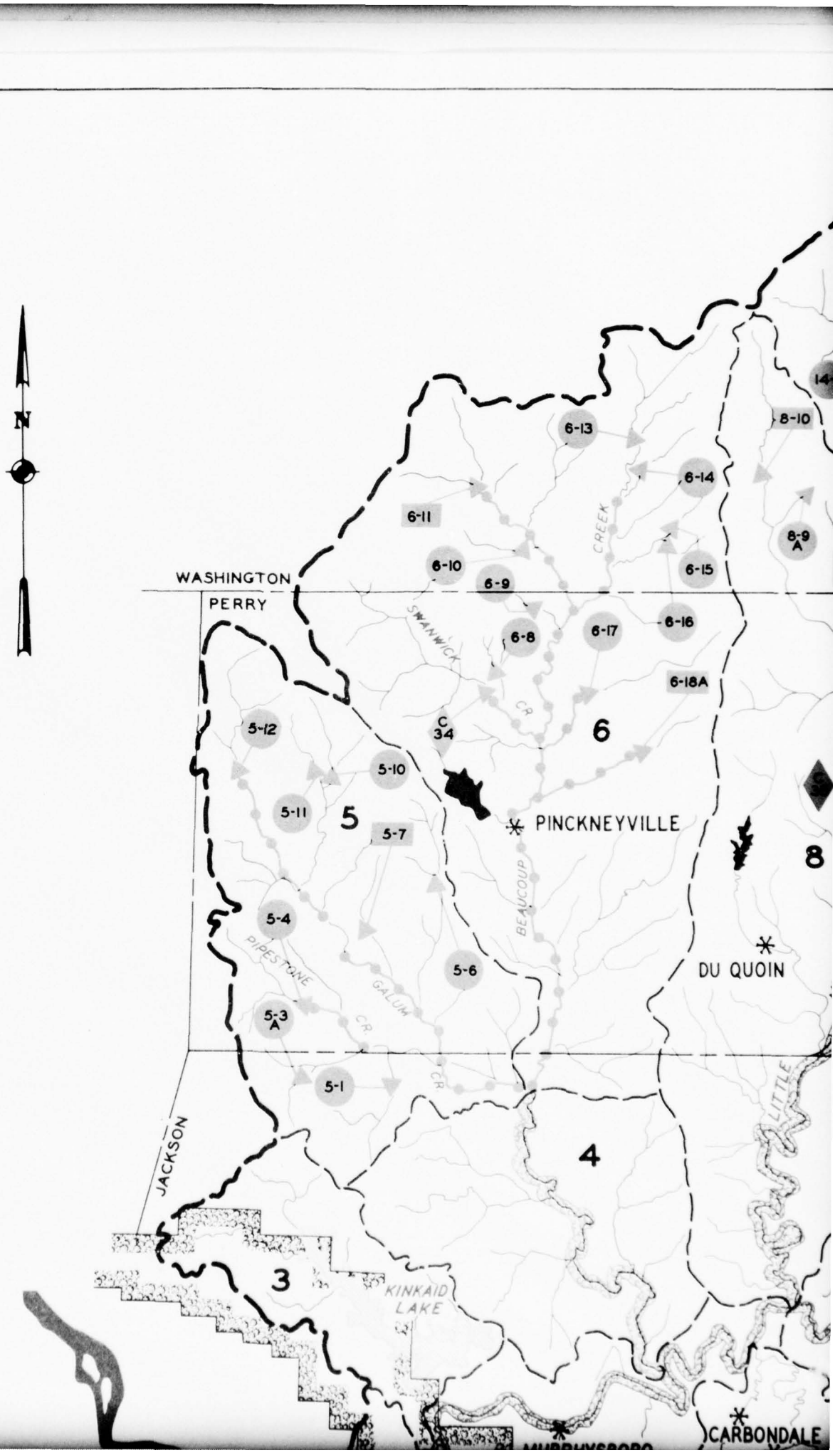
(2) Studies required. In addition to the structural and nonstructural aspects of the early action program, it was concluded that there was a concurrent need for certain supplemental studies. These studies would be of the type that would eventually lead to additional action programs at the Federal, State, and local levels. Of prime importance from the Federal standpoint is the study that would define the strip mine problems and establish an action program designed to restore the income potential of these areas. This program would help restore the tax base of the Conservancy Districts, which, together with the State, are viewed as logical co-sponsors of the structural and nonstructural project elements in the early action program. The two studies, one concerning preparation of the basin-wide master plan for recreational development, and the other, establishing the recreational-environmental corridors, should be included as part of the authorizing report prepared by the Corps of Engineers

TABLE M-31

Early action program, structural and nonstructural

Watershed	Recommended Improvement		Project First Cost
Nos. 1 & 9 Main stem Big Muddy River	Stream corridor		$ 9,200,000
No. 12 Middle Fork	Corps reservoir	C-7	20,600,000
	SCS reservoirs	12-1	851,000
		12-7A	285,000
No. 7 Lower Crab Orchard Creek	Corps reservoir	C-16A	12,000,000
No. 8 Little Muddy River	Corps reservoir	C-35	28,500,000
	Stream corridor		3,500,000
No. 14 Upper Big Muddy River	SCS reservoirs	14-7	1,070,000
		14-6	281,000
		14-2	645,000
		Subtotal No. 1	$76,932,000
No. 12 Middle Fork	Land treatment measures		1,968,000
No. 8 Little Muddy River	Land treatment measures		5,796,000
No. 14 Upper Big Muddy River	Land treatment measures		1,464,000
		Subtotal No. 2	$86,160,000
No. 2 Cedar Creek	Reservoirs		4,052,000
		Grand Total	$90,212,000
	Percent of overall basin plan cost		39.42

in implementing its portion of the early action program. While both will involve those Federal, State, and local agencies having an interest in these studies, it is imperative that the Illinois Department of Conservation also prepare a supplemental master plan establishing the framework for long-range recreational development and planning. During the study effort, it was recognized that man's use of the land has greatly increased the rate of erosion and thus the amount of sediment carried in the stream. Unfortunately, there are no sediment discharge records available to formulate an effective action program to overcome this problem. As a partial solution, emphasis has been given the need for land treatment and flood control measures. These will minimize sheet and channel erosion and thereby diminish the streams' sediment load. What is still required is the collection of basic data to identify known problem areas and their specific causes. The study should give initial emphais to those watersheds where developments are immediately contemplated. Furthermore, concerted effort is required to establish a basin-wide remedial program; otherwise these losses will continue, although at a lesser rate. It is recommended that these studies be undertaken by the Conservancy Districts in cooperation with the Soil and Water Districts and supplemented by proper land zoning. Another study is needed to detail the various archaeological, historical, and other cultural features that should be preserved and incorporated into the various watershed developments. Because of its active support and contribution to this study, it is recommended that Southern Illinois University undertake these additional investigations under contractual arrangements with the National Park Service. The findings should then be incorporated with the appropriate zoning action in the counties' land-use plan in order to enhance the socio-environmental aspects of the basin. There is also a definite need for a major planning effort on the part of local interests. Implementation of the early action program will necessitate the needs for certain studies by the Greater Egypt Regional Planning and Development Commission. At least four major studies are required. First, there is a need to update the existing land-use plan by recognizing the impact that the early action program will have on the patterns and allocations of specific land-use categories and by incorporating the induced effects on the area's socio-economic resources as will accrue from the growth-center concept. A second study would evaluate the effects of water supply distribution systems on the five-county tax structure and its demographic patterns. This study would determine the impact that the present and proposed intercity water systems have on growth patterns and establish the necessary controls required for orderly development. These controls would include technical and administrative guidelines necessary to both protect the planned public investments and to help support the municipal and industrial growth. A third study would investigate the feasibility of intercity sewage collection and treatment. There is a growing economic interdependence between the communities and a need to avoid duplication of services, even in meeting the State's stream quality standards.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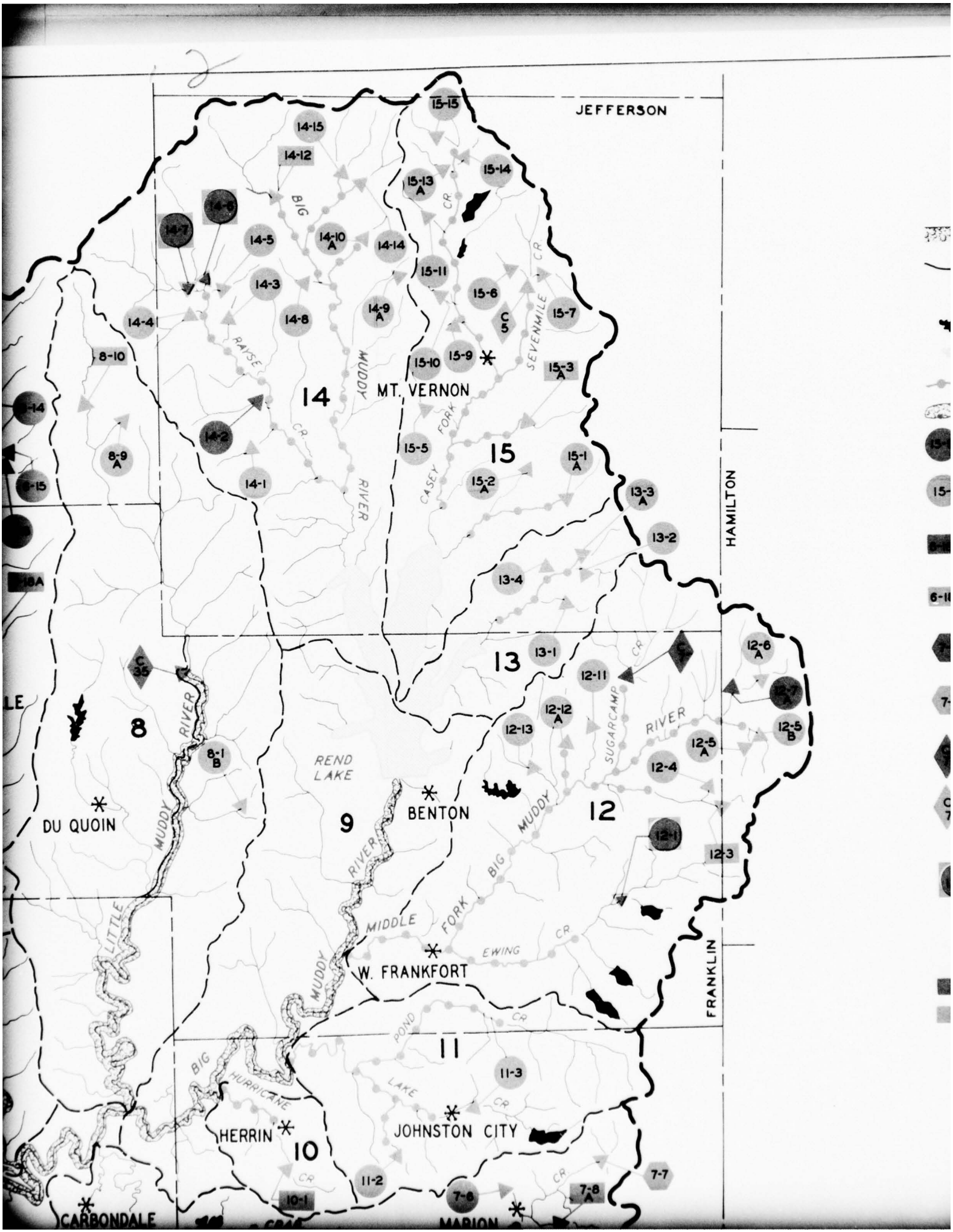
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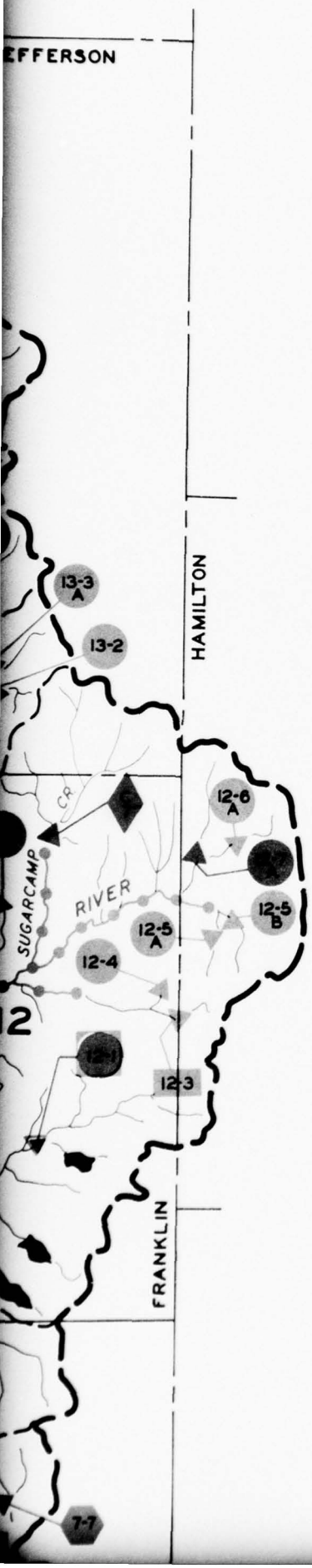
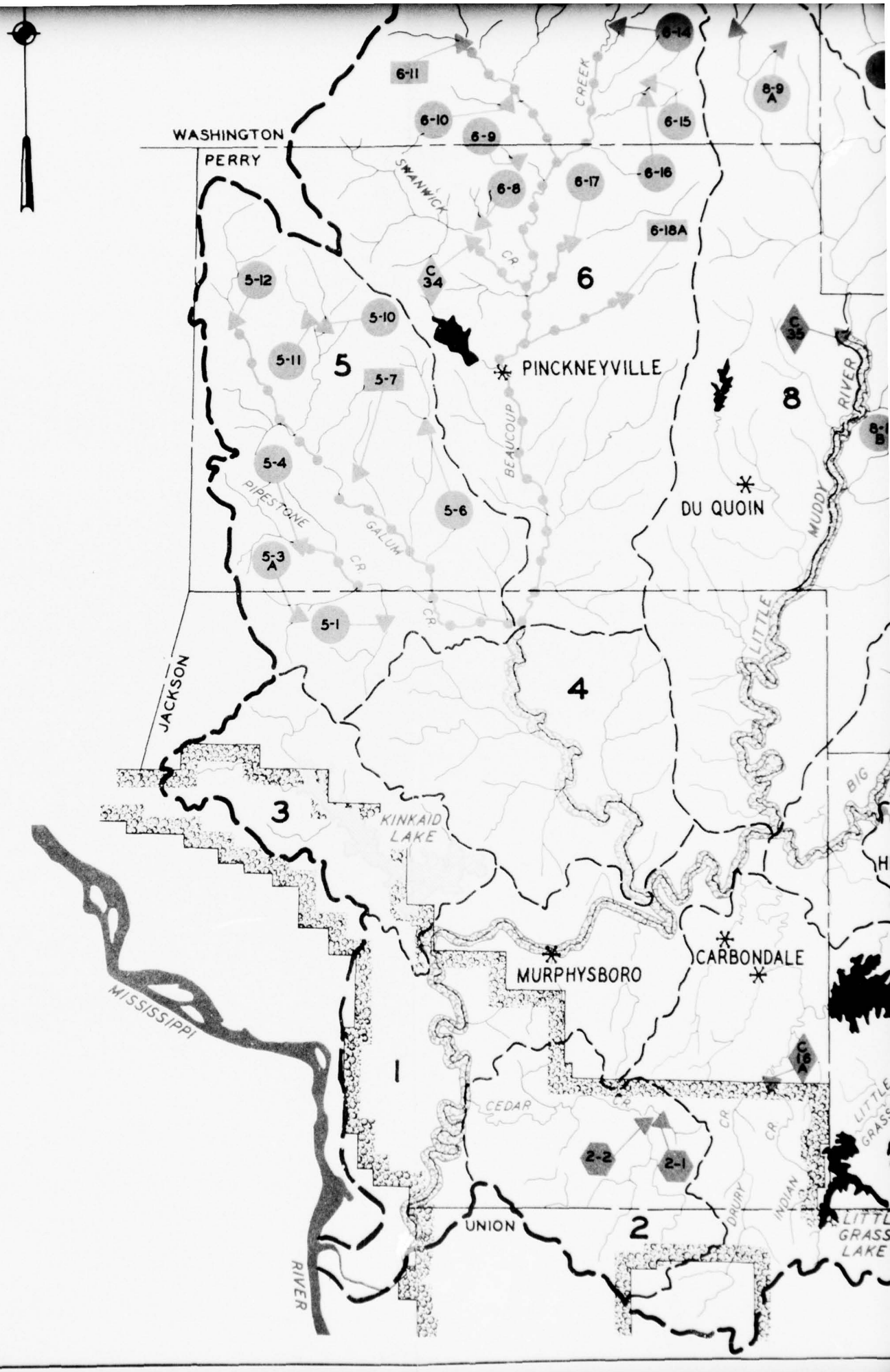


LEGEND

- Shawnee National Forest
- Sub-basin Outlines
- Sewage Treatment Plant Outfall - Existing
- Reservoirs Completed
- Reservoirs Under Construction
- Soil Conservation Service Channel Improvements
- Recreational Corridors
- Soil Conservation Service - Single - Purpose Floodwater Retarding Structure (15-9)
- Soil Conservation Service - Dual - Use Reservoir Flood Control and Recreation (6-18A)
- Soil Conservation Service - Multiple - Purpose Reservoir (7-7)
- Corps of Engineers - Multiple - Purpose Reservoir (C, C 7)
- Soil Conservation Service - Two - Stage Reservoir Construction (12-1):
  - a.) Single Purpose Flood Control Initial Construction
  - b.) Second Stage Addition for Recreational Storage
- 10-15 Year
- Long Range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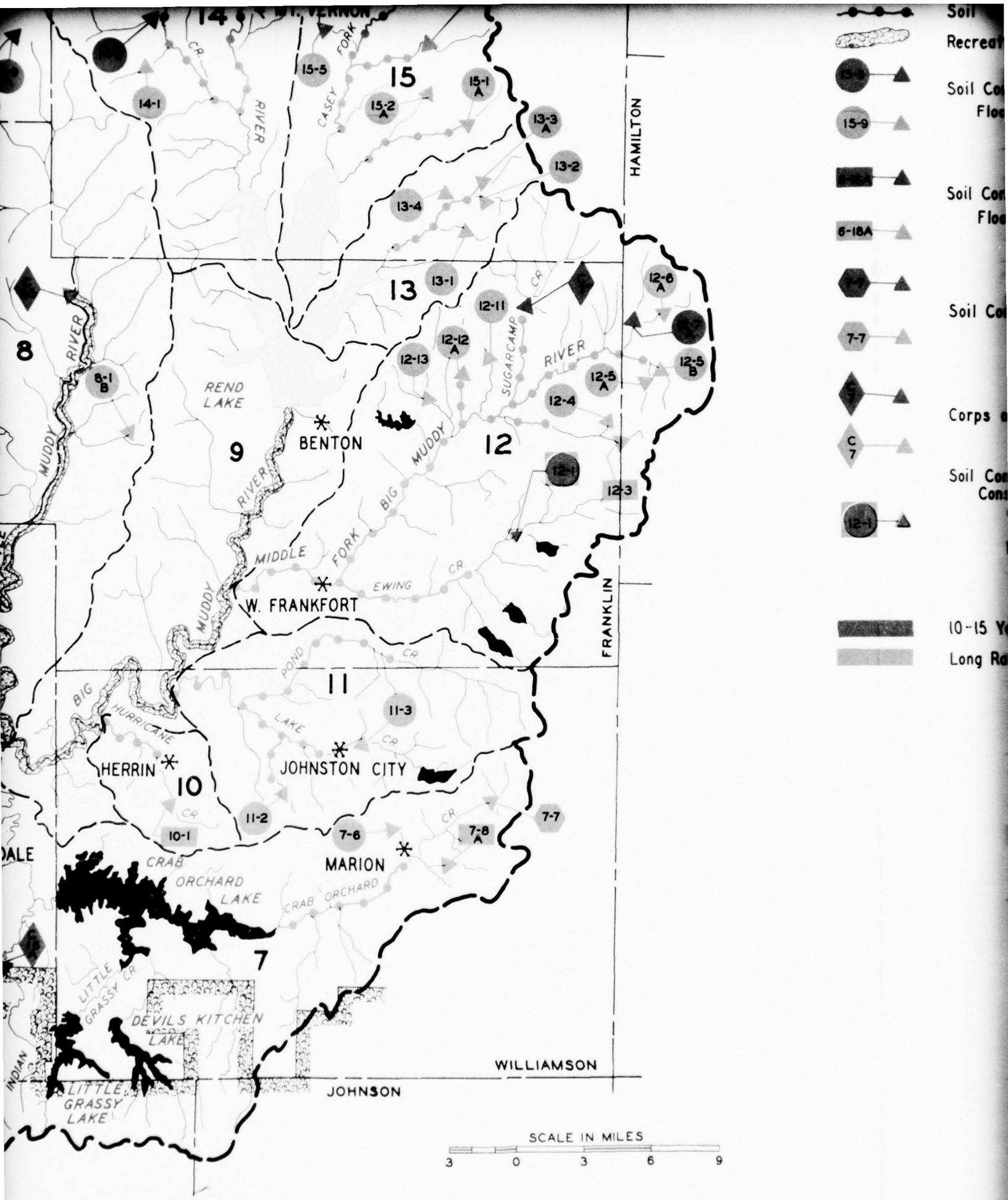
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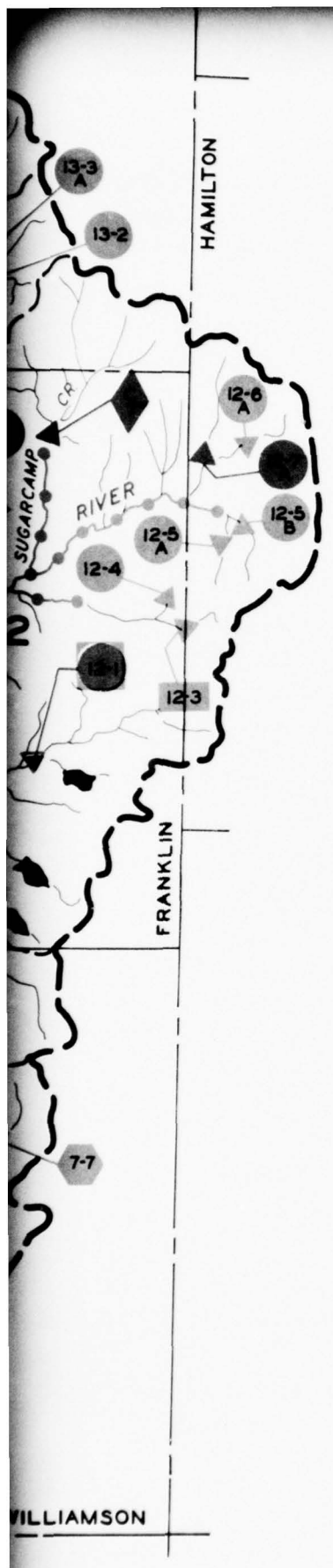

Soil Conservation Service Channel Improvements

Recreational Corridors

Soil Conservation Service-Single-Purpose
Floodwater Retarding Structure

Soil Conservation Service-Dual-Use Reservoir
Flood Control and Recreation

Soil Conservation Service-Multiple-Purpose Reservoir

Corps of Engineers-Multiple-Purpose Reservoir

Soil Conservation Service-Two-Stage Reservoir
Construction:
a.) Single Purpose Flood Control
Initial Construction
b.) Second Stage Addition for
Recreational Storage

10-15 Year

Long Range

SCALE IN MILES
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RECOMMENDED PLAN OF IMPROVEMENT
BIG MUDDY RIVER BASIN, ILLINOIS

PLATE 4

Accordingly, a study appears warranted wherein all feasible alternative solutions for regional control of sewage collection and treatment of effluents are evaluated. Finally, there is a growing need for a reevaluation of the local governmental organizations. The multiplicity of functional, local governmental institutions has lead to some taxing and service deficiencies. If the needed services are to be provided, the multiplicity of local governmental structures, their composition, and ability to effectively coordinate and be responsive to all phases of participation must be evaluated and if at all possible, consolidation effected. In addition to the foregoing, there will be the need for the Conservancy Districts to coordinate their studies for off-project developments with the regional planning agency. The build-up that will logically occur, will require correlation in updating existing land-use plans, passage of zoning ordinances; and in-depth studies relative to community services, jobs, industrial developments, transportation facilities, agricultural improvements, and those facilities designed to satisfy the total spectrum of tourism and recreational demands. Early completion will be dependent upon the priority accorded these studies by those Federal and State agencies providing financial assistance through various grant-in-aid programs. Participation of such agencies as the Economic Development Administration of the Department of Commerce and the Department of Housing and Urban Development is vital if the area's redevelopment is to be achieved.

SECTION X - FINANCIAL REQUIREMENTS FOR IMPLEMENTATION

46. COST SHARING POLICIES

The limited financial capability of both the State and local governmental entities was recognized as a major factor in the basin's failure to keep pace with the national growth. Consequently, while responsibility for both preconstruction planning and ultimate development of those projects in the early action program has been assigned the construction agencies, current Federal policy concerning cost sharing requirements was also reviewed. It was recognized that specifying the precise terms of local cooperation in any Federal project or cooperative program is the prerogative of Congress, which authorizes the program or participation therein. Hence, the requirements for local cooperation, including cost apportionments, for any project or program which may be authorized by Congress may differ from the information presented herein. Furthermore, Federal interest is heavily involved in the early action program and requires an evaluation of the scope of financial commitments. The multi-purpose projects have been designed as satellite to, and part of a system, that includes Rend Lake as its nucleus. Because of this system relationship, the institutional cost-sharing precedures utilized for the Rend Lake project were adopted for this study since they reflected Congressional intent, particularly concerning area redevelopment as a project purpose. Authorization of the Rend Lake project indicated a Congressional interest and commitment to this portion of southern Illinois that is uniquely different from other water resource developments. Accordingly, comparable cost assignments have been made for area redevelopment and other project purposes, including low-flow augmentation. Application of these cost allocation and apportionment procedures was restricted to only those multiple-purpose projects where area redevelopment was a project purpose. Since the major multiple-purpose projects were designed within the context of a functional system, deviations may occur relative to the cost (allocation) limitations for recreational enhancement set forth in Section 9 of the Federal Water Project Recreational Act, Public Law 89-72. This is to be expected on a project, but not on a system basis since the recreational returns were maximized, both from a need and economic standpoint within the system. While the principles governing the need to conserve, preserve, or enhance the environment have been defined from a national objective standpoint, the applicable policy for cost divisions has not been established. Since public use and enjoyment are implicit in the environmental program, the method of apportionment established by Public Law 89-72 was used as a guideline for purposes of this study. The statute requires that no more than one-half of the separable first costs shall be borne by the United States, and that operation, maintenance, and replacement costs shall be a non-Federal responsibility. There may be valid reasons, however, for deviation from this cost division,

if the preservation of certain areas having unique archaeological, historical, or natural significance is warranted from a national standpoint. Then, the acquisition and any necessary development should be a Federal cost.

47. COST APPORTIONMENT

A division of first costs between Federal and non-Federal interests was determined on a functional basis as set forth in existing statutes and the procedures outlined in the preceding paragraph. Functional allocations of project costs were based on the criteria applicable for improvements constructed under Public Law 566, 83rd Congress, 68 Stat. 666, as amended, and the use of separable costs-remaining benefits method for those multiple-purpose reservoirs recommended for implementation by the Corps of Engineers. The results of the cost allocation and apportionment study are shown in TABLE 32. The apportionment should be considered preliminary in nature and has been evaluated only to indicate the scope of non-Federal investment required in implementing the early action program.

TABLE M-32

Apportionment of costs, early action program

Project Element	Total Project First Costs ($)	Division of Costs ($) Federal	Non-Federal
Corps of Engineer Reservoirs			
C-7	20,600,000	18,865,000	1,735,000
C-16A	12,000,000	11,138,000	862,000
C-35	28,500,000	25,833,000	2,667,000
Subtotal	61,100,000	55,836,000	5,264,000
Soil Conservation Service Reservoirs			
12-1	851,000	572,000	279,000
12-7A	285,000	190,000	95,000
14-2	645,000	428,000	217,000
14-6	281,000	221,000	60,000
14-7	1,070,000	638,000	432,000
2-1	898,000	267,000	631,000
2-2	3,154,000	441,000	2,713,000
Subtotal	7,184,000	2,757,000	4,427,000
Stream Corridors			
Main Stem Big Muddy River	9,200,000	4,600,000	4,600,000
Little Muddy River	3,500,000	1,750,000	1,750,000
Subtotal	12,700,000	6,350,000	6,350,000
Land Treatment Measures			
Watershed No. 8	5,796,000	3,478,000	2,318,000
Watershed No. 12	1,968,000	1,181,000	787,000
Watershed No. 14	1,464,000	878,000	586,000
Subtotal	9,228,000	5,537,000	3,691,000
Grand Total	90,212,000	70,480,000	19,732,000

FORMAL COMMENTS

APPENDIX M

United States Department of the Interior

OFFICE OF THE SECRETARY
UPPER-MISSISSIPPI WESTERN GREAT LAKES AREA
2510 DEMPSTER STREET
DES PLAINES, ILLINOIS 60016

February 23, 1971

Colonel Carroll N. Letellier
District Engineer
U. S. Army Engineer District,
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Letellier:

Confirming my conversation with Mr. James Maas, I have reviewed the Appendix M of the Big Muddy Comprehensive Basin Report. I feel that the Study has carefully evaluated the alternatives and developed a plan which has strong public support in the area.

The Big Muddy Basin is part of the depressed area of Southern Illinois which has been a drag on the economy of the nation. Implementation of this plan would add impetus to the economic revival which is being generated by the Rend Lake Reservoir. Everything industry needs is waiting in Southern Illinois - still at bargain rates!

I feel that this plan would contribute materially to the national income and substantially to the regional economic development of the basin.

Very truly yours,

Burton H. Atwood

Burton H. Atwood
Field Representative
North Central Region

United States Department of the Interior

BUREAU OF MINES

Twin Cities Mineral Supply Field Office
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

February 3, 1971

Colonel Carroll N. LeTellier
Chairman, Coordinating Committee
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

We have reviewed Appendix M, Plan Formulation to the Big Muddy River, Illinois, Comprehensive Basin Study and have no changes to suggest.

Mr. W. A. Grosh has been appointed Bureau of Mines Liaison Officer for Minnesota and is no longer affiliated with this office. Mr. D. F. Klyce of the Minneapolis field office will represent the Bureau of Mines on this study.

Very truly yours,

Matthew G. Sikich
Acting Chief

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
NORTHEAST REGION
143 SOUTH THIRD STREET
PHILADELPHIA, PA. 19106

IN REPLY REFER TO:
L7423
NER(CP)

February 18, 1971

Mr. A. J. Tiefenbrun
Asst. Chief, Engineering Division for Planning
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Tiefenbrun:

The opportunity to review Appendix M, Plan Formulation, on the Big Muddy River, Illinois, Comprehensive Basin Study is sincerely appreciated. The appendix is a worthwhile document which clearly reflects the careful, detailed planning input of the study.

We are especially pleased to note the utilization of the stream corridor concept and, with reference to this feature, offer the following observations:

1. The Appendix should contain brief succinct definitions of both environmental stream corridors and linear corridors.

2. The designation, "Environmental Stream Corridor", is preferable to "Stream Recreation Corridor". The latter implies that hunting and fishing are the main purposes of the corridor. Actually the stream corridor involves vastly more. It is a device for perpetuating natural and cultural values, creating greenbelts and open space. The corridor is in short an instrument for enhancing the quality of the total environment.

The appendix does not direct attention to visually aesthetic values in the Basin. A county by county inventory of these values should be recommended for early study.

The recent publication of the Illinois Register of Historic Places should be noted and its contents mapped to insure the preservation of the more important significant resources.

The early study recommendations should call for an inventory of natural areas which contain scientific, ecological and educational values.

In view of the wealth of archeological values which span the entire pre-contact period, additional surveys and archeological investigations should be recommended. The Big Muddy River Basin appears to be an excellent resource base for establishing meaningful historical continuities of aboriginal life in this area prior to the coming of the white man. This is a rare opportunity.

Sincerely,

Harold I. Lessem

Harold I. Lessem
Federal Liaison
Federal, State & Private Agency Assistance

United States Department of the Interior

IN REPLY REFER TO

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

Mpls. Area Office - RBS
Federal Bldg., Fort Snelling
Twin Cities, Minnesota 55111

February 12, 1971

Col. Carroll N. LeTellier,
District Engineer
U. S. Army Engineer District
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Col. LeTellier:

I have reviewed the final field version of Appendix M (Plan Formulation), Big Muddy River Comprehensive Basin Study.

This document reflects considerable credit on your planners. I heartily subscribe to the recommended program for "early action." The proposed reservoirs, together with 150 miles of recreational-environmental corridors and the land treatment measures will go far in maintaining the rich environmental qualities of the Big Muddy River Basin. Fish and wildlife values will be maintained and the quality of the area's streams will be enhanced. The quality of stream fishing opportunities will be increased. Furthermore, the studies outlined for concurrent implementation, particularly the strip mine rehabilitation study, are both well advised and timely.

Thank you for the opportunity to provide these field level comments. I have enjoyed working with Mr. Maas and your office throughout the course of this study and I hope to have the opportunity to see the recommended "early action" program come about.

Sincerely,

Donald B. Vogtman

Donald B. Vogtman
Supervisor

United States Department of the Interior

GEOLOGICAL SURVEY

2222 Schuetz Road, Suite 212
St. Louis, Missouri 63141

February 5, 1971

Your ref: LMSED-BG

District Engineer
St. Louis District
U. S. Army Corps of Engineers
210 N. 12th Street
St. Louis, Missouri 63101

Dear Sir:

This is to acknowledge receipt of the final field version of Appendix M, Plan Formulation, of the Big Muddy River Comprehensive Basin Study. The U. S. Geological Survey has reviewed this appendix and finds no conflict with the information gathered in our studies of ground water and geology.

Sincerely yours,

Elwood R. Leeson
Regional Hydrologist, MCR
Water Resources Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
LAKE CENTRAL REGION
3853 RESEARCH PARK DRIVE
ANN ARBOR, MICHIGAN 48104

D6427UM
Big Muddy

February 9, 1971

District Engineer
U. S. Army Engineer District,
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Sir:

In response to your letter of January 20, 1971, (LMSED-BG), we have reviewed the final field version of Appendix M, Plan Formulation, to the Big Muddy River Comprehensive Basin Study, Illinois, and the following comprise our formal field comments.

> While the selection of water resource development projects to ". . .serve as a base for the subregional development of a total tourism and recreational industry. . ." (page 27, paragraph 18 c. (3)) may be a valid objective for plan formulation, this concept was not considered in the recreational demand, supply, and needs analysis of the basin.
>
> The plan, as formulated, has considerable merit and if implemented should support and stimulate much local activity for the better life.

Sincerely yours,

ROMAN H. KOENINGS
Regional Director

By: John D. Cherry
John D. Cherry
Acting

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service Central Region
Room 1836, 601 E. 12th Street
Kansas City, Missouri 64106

February 11, 1971

WFC2

District Engineer
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Subject: Big Muddy River Comprehensive Basin Study

Reference: LMSED-BG, January 20, 1971

Dear Sir:

Appendix M, Plan Formulation, 1970, has been reviewed.

The study appears to be in agreement with the national objective for developments responsive to the enhancement of environmental quality and social well-being of the basin. It also meets a regional objective which requires that resources developments be designed to satisfy an equitable part of the Nation's needs.

The prototype studies for a flood frequency recurrence interval of 50 years, as expressed in Section II, indicate approximately 157,000 acres subject to flooding, 43,000 of which have some level of protection by reservoirs constructed or under construction. Until such a date as additional structures are installed, alternate methods for reducing flood losses should continue to be given primary consideration. Flood plain zoning, when used in conjunction with flood proofing and flood forecasts, is an effective non-structural approach to attaining flood management objectives. These methods are particularly applicable when the benefit-cost ratio does not justify a public investment in flood control structures.

Very truly yours,

VERNE ALEXANDER
Regional Hydrologist

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P.O. Box 678, 200 W. Church St., Champaign, Illinois 61820

February 5, 1971

Colonel Carroll N. LeTellier
District Engineer - LMSED-BG
U. S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

The Forest Service, Economic Research Service, and Soil Conservation Service have reviewed the final field version of Appendix M, Plan Formulation, for the Big Muddy River Comprehensive Basin Study. Since this document is essentially the same as previously reviewed, we have no additional comments to make.

We appreciate the opportunity to review and comment on this final field version.

Sincerely,

Howard W. Busch
State Conservationist

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION V
433 WEST VAN BUREN STREET, ROOM 712
CHICAGO, ILLINOIS 60607
PUBLIC HEALTH SERVICE

February 5, 1971

Your Reference: LMSED-BG

Colonel Carroll N. LeTellier
District Engineer
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Reference is made to your recent letter concerning the final field version of Appendix M, "Plan Formulation" to the Big Muddy River, Illinois, Comprehensive Basin Study.

Please be advised that this office has completed a cursory review of the above-mentioned appendix and that we do not have comments of substantial significance at this time.

Sincerely yours,

Donald W. Marshall

Donald W. Marshall, P.E.
Sanitary Engineer Director
U. S. Public Health Service

FEDERAL POWER COMMISSION
REGIONAL OFFICE

610 South Canal Street, Room 1051
Chicago, Illinois 60607

January 25, 1971

Colonel Carroll N. LeTellier
District Engineer
Chairman, Coordinating Committee
Big Muddy River, Ill., Comprehensive Basin Study
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Receipt is acknowledged of your letter dated January 20 forwarding the final field version of Appendix M, Plan Formulation, to the Big Muddy River, Ill., Comprehensive Basin Study.

We have reviewed Appendix M and concur in its contents. This concurrence is made at field level and is not to be construed as that of the Federal Power Commission itself.

Sincerely yours,

Lenard B. Young
Regional Engineer

UNITED STATES OF AMERICA
ENVIRONMENTAL PROTECTION AGENCY
REGION V
WATER QUALITY OFFICE
33 East Congress Parkway
Chicago, Illinois 60605

February 18, 1971

Colonel Carroll N. LeTellier
District Engineer
U. S. Army Engineer District,
St. Louis
210 No. 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

The final field version of Appendix M, Plan Formulation, Big Muddy River Comprehensive Basin Study has been reviewed. This appendix was prepared with the assistance of my staff and adequately presents the water quality management program that must be undertaken in this basin. I would like to highlight paragraph 40.b which summarizes how the low flow management program can be coordinated with the expanding program of advanced waste treatment and requires that a review of the proposed low flow management program must be undertaken prior to project design for the designated reservoirs. There have been significant modifications in the water quality management program since this study was initiated and more changes in policy and technology can be expected prior to construction.

This study has recognized through the environmental corridor program, that improved stream water quality will have an effect on the basin economy. I have previously addressed the issue of coordinating recreational and water quality benefits in my review of Appendixes N and H. The clarification of this issue in the review process should facilitate future work on the basin program.

Sincerely yours,

Francis T. Mayo
Regional Director

RICHARD B. OGILVIE
Governor

RAY C. DICKERSON
Director

STATE OF ILLINOIS
DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

February 24, 1971

Colonel Carroll N. LeTellier
District Engineer
Department of the Army
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Reference is made to your letter of January 7, 1971, File LMSED-BG asking for State comment on the final field version of Appendix M, Plan Formulation, for the Big Muddy River Comprehensive Basin Study.

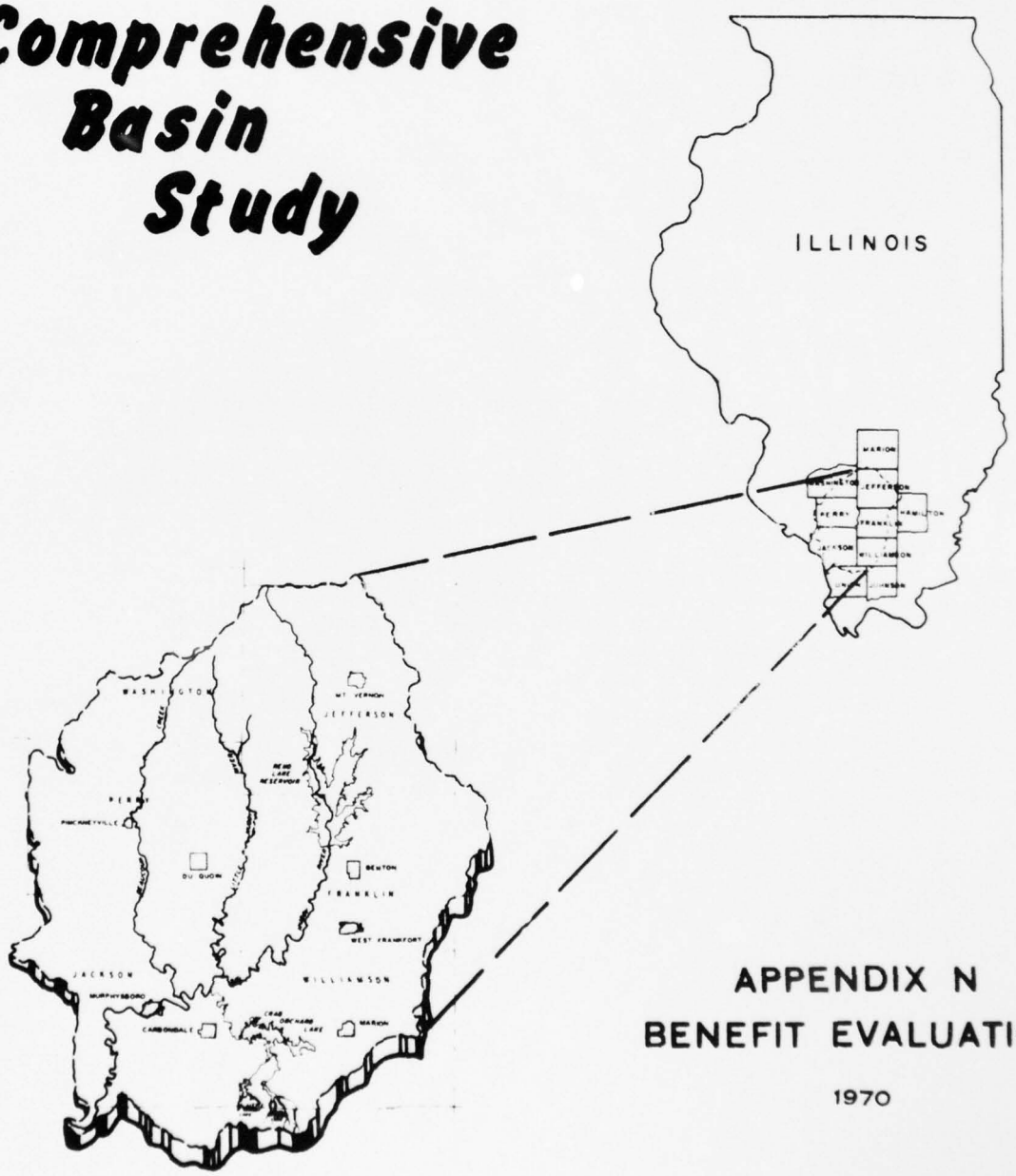
The Natural Resource Development Board has reviewed the report and has no adverse comment to make at this time. However, we wish to advise that the Department of Conservation will not be in a position to render its opinion on this report for some three to six months.

Sincerely,

Ray C. Dickerson

BIG MUDDY RIVER

Comprehensive Basin Study



APPENDIX N
BENEFIT EVALUATION

1970

Prepared by Corps of Engineers

TABLE OF CONTENTS

TABLES

SECTION I - INTRODUCTION

1. PURPOSE AND SCOPE

The purpose of this appendix is to quantify the value of those needs which require fulfillment if the basin is to achieve its projected socio-economic growth. The needs were evaluated as equivalent to the difference between the projected, time-phased demands and the existing and expected supply of the basin's various resources. These studies, the results of which are presented in supporting appendices and summarized herein, were undertaken by individual work committees chaired by agencies having expertise in the particular subject.

2. DEMANDS FOR PRODUCTS AND SERVICES

The evaluation of the short- and long-range demands associated with the basin's resources recognized that each analysis would have a uniqueness inherent to that particular type of product or service. A distinction was made among demands for water-related resources, land-related resources, and socio-economic and environmental considerations. Included in the water-related group was the potential for providing flood control, municipal and industrial water supply, low-flow augmentation, general recreation, improvement of stream fishery, hydropower generation, and navigation. Land-related services encompassed such evaluations as drainage, erosion, irrigation, steam-power generation, hunting needs, and strip-mine rehabilitation. Socio-economic considerations involved the concern for improving the area's economic base structure. Environmental considerations included preservation or development of archaelogical and historical artifacts, as well as significant natural or cultural resources.

3. RESULTS OF NEED EVALUATION

Comparison of demands to both existing and potential supplies for each type of product or service indicated that there were selective needs within each of the resource development groups. Within this framework, however, there were many needs, the satisfaction of which cannot or should not be measured in purely monetary terms. This is particularly true where developments are required to enhance either the area's environmental quality or social well-being. Discussion of those needs incapable of being quantified monetarily at this time (intangible benefits) is presented in Appendix M, Plan Formulation. These needs, for which action programs were eventually formulated, involved concern for: improvement to stream fishery; preservation of archaeological and historical artifacts; development of certain natural and cultural (environmental) resources for improved management of wildlife habitat and rehabilitation of strip-mine areas; and conservation of those areas having aesthetic and ecological value. Thus the evaluations presented in this Appendix have been restricted to those

need categories that are quantifiable (tangible) in monetary terms. In order to establish the creditable monetary worth or benefits, a differentiation was made between needs that had either a national or regional significance. Those needs in the first category would contribute directly or indirectly to the nation's economic development by increasing the value of the nation's output of goods and services thereby improving the national economic efficiency and social well-being. In essence, the applicable benefits reflect a basic return to the user and/or increased value in resource utilization. The second category of needs and accruing benefits represents an enhancement to the region's socio-economic structure that results from investments or services made to achieve the national objectives. By definition, the value represents an additional (supplemental) return that would accrue primarily to the local area once the commitments for the basic resource developments are achieved. In each case, only the net worth was derived, being computed as equivalent to the creditable gross value less any associated cost incurred in the realization of these benefits. Based on the foregoing, evaluation of the tangible benefits was confined to the specific needs associated with agriculture, namely, flood damage reductions in the bottom lands and drainage of selected wet lands; low-flow augmentation in the interest of improving stream quality and providing a minimum base flow where conditions so warrant; general recreational developments required to satisfy the unmet demands for water-related activities; and the need to further the governmental efforts to redevelop the region's economic structure. Preliminary investigations of two other remaining needs, navigation and water supply, indicated that navigational channel improvements were not economically justified (see Appendix G) and that sufficient alternative sources exist to satisfy the projected water supply deficiencies (see Appendix M).

SECTION II - BASIS FOR BENEFIT EVALUATION

4. FACTORS AFFECTING ANALYSIS

In quantifying the worth of the goods and services to be provided, various constraints or factors were considered. The time of need was recognized at the outset as a major factor in determining the value of the projected needs. A time phasing was established to differentiate between the near future (1980) and the long-term future needs (2020), and served as a basis for discounting the value of these needs to present worth. The geographic distribution of the needs associated with both water and land resources was also an influencing factor. Control of the water regimen for the major portion of the main stem, Big Muddy River, will be provided with completion of Rend Lake now scheduled in 1974. Therefore, the location of various need centers that would be considered in any plan formulation analysis dictated the need for an individual tributary watershed approach. Furthermore, it was recognized that fulfillment of some needs could be attained only through a systemized approach in terms of resource control while others would be influenced by specific locational considerations. In evaluating the economic worth of future requirements, estimates of needs were first analyzed as to the degree of reliability and practicality that water-related developments can be effective. Once the level of service capable of being provided was known, benefits were then determined. In those cases where the value accrues at varying time-phased rates, the future incremental worths were discounted to the base year, 1980, (anticipated start of project operation) and distributed as an equivalent uniform value over a period of economic analysis, 100 years. The Federal interest rate of 5-1/8 percent was used in the discounting procedure and all costs or damages are expressed in 1970 dollars. In determining the economic value of the identified resource needs, certain governing criteria or considerations were established. These are identified in the following paragraphs.

5. FLOOD CONTROL

Flood control benefits were based on an analysis of selected prototype reaches, which showed the economic inadvisability of attempting to decapitate major peak flows. It was found that the major beneficial flood damage reductions would be obtained by retention of the more frequent floods, particularly those flows having a frequency of occurrence ranging from 1 to 3 years; furthermore, that any effective reduction in flooded acreage required a completely controlled water regimen. This would require structures strategically located so as to control local flood runoff, rephase time of concentration, and reduce peak flows. Successive hydrological screenings eventually identified the optimum plan of improvement as one that would control a minimum of 25 percent of the watershed area and maintain a maximum control release rate of from 10 to 15 c.f.s. per square mile. Flood control

benefits were determined with the use of price standards consistent with the "Interim Price Standards for Planning and Evaluating Water and Land Resources," April 1966, Water Resources Council, and included the value of flood damages prevented and future increases in return possible of attainment under the optimized controlled hydraulic gradient. Where conversion of land use was involved, the additional creditable value was discounted to reflect the degree of participation by the land owners and a time lag for conversion and attainment.

6. DRAINAGE

Present land use, as well as soil types, was used to identify the acreage having a potential for drainage improvements. The scope of drainage improvement that would be made feasible by the system-induced reductions of the more frequent floods was established for each watershed, with adjustments made to recognize the backwater effects from the main stem. Provision for channel improvements was confined to those areas where sufficient lands could be benefited, on acreages that would be benefited by flood reduction, and where adequate outlets for drainage systems could be installed. Based on the foregoing, preliminary screening showed that out of 661,000 acres of inherent wetland, 236,500 acres have economic potential for some degree of drainage improvement. This acreage included lands in and adjacent to the floodplain.

7. GENERAL RECREATION

Evaluation of the outdoor water-related recreational demand utilized the populations of the five-county core area and selected SMSA in both the Upper Mississippi River and the adjoining Ohio River Basins. The analysis recognized Southern Illinois and the Big Muddy Basin in particular as a potential resource area for accommodating some of the locally unsatisfied demands for upstate Illinois. Factors considered in the analysis were: the time-distance travel relationship of the population residing within the basin's zone of influence; the impact that three interstate highways will have in establishing the area as a focal point for outside origin-destination travel; length of recreational season for both the demand and service areas; and the present and potential land use in both the Big Muddy Basin and the recreation-market areas. In computing the recreational demands, per capita participation rates for selected activities were applied to portions of the population located within the zone of influence. These then were converted to recreation days, using a factor of 2.5 activity occasions per recreation day. To this base, a portion of the vacation travel originating outside the zone of influence was added. This latter segment represented an impact creditable to those people whose origin-destination travel would be directed toward seeking partial or total satisfaction within the basin. Existing and programmed resource developments have been estimated as sufficient to accommodate about 69 percent of the 1980 demand and about 44 percent of the year 2020 demand. While participation in all water-related

activities is projected to increase substantially, those activities showing the greatest increase and having the greatest impact on resource requirements are boating, water skiing, and camping.

8. LOW-FLOW AUGMENTATION

Analysis regarding stream quality was based on maintaining a State designated standard required for sustaining fish and aquatic life. Six load points were identified as needing low-flow augmentation to supplement the required at-source waste treatment of urban-related discharge. All were located in the tributary or headwater areas since provision for main stem control had been included in the formulation of the authorized Rend Lake project. Subsequently, it was determined that adequate stream quality could be maintained by low-flow augmentation for five of the six major point areas, the exception being in the environmental area of Carbondale. There, hydraulic studies indicated that even though the required dilution flows could not be provided, a definite need to supplement natural flows for the express purpose of maintaining a minimum base flow did exist. As identified by the Public Health Service, this base flow is required for flushing the stream and preventing vector problems and other health and social nuisances from developing. Since this flow is not adequate for water quality control, improved at-source treatment of community's waste load or transfer to the Big Muddy River where adequate dilution flows are provided by the Rend Lake Reservoir will be required. Results of these hydraulic studies and functions of flow supplementation were approved by the State of Illinois. Based on the foregoing, the value of the storage provided for low-flow augmentation was then evaluated as the equivalent worth of that alternative which would most likely be undertaken in lieu of providing increased flows.

9. ECONOMIC REORIENTATION

The Big Muddy Basin presently is substantially below the national average in terms of personal income. An attempt has been made to rectify this situation through several on-going Federal and State programs, namely, Rend Lake and Kinkaid Lake. The effects of these projects have been to stem out-migration from the region and stabilize the economy of the basin at a somewhat higher level, although still below the national average. While some of the impact from these programs have already been felt, major gains in population, employment, and income will occur during the decade 1970-1980. The proposed developments which will be constructed during the current decade will have their major impact on the reorientation of the basin during the 1980-1990 period. This will permit the economy of the area to continue its growth toward the national average. Water-related developments provide a stimulus to the local economy in many ways. These include development of the recreational industry, increased residential, commercial, and industrial construction, and investment of local government in new and expanded facilities. It is anticipated that the present and projected programs will have a substantial effect on the area, thus raising personal income in the basin to parity with that of the United States.

SECTION III - NATIONAL ACCOUNT BENEFITS

10. FLOOD CONTROL

a. General. The degree of flood control warranted was evaluated for all lands in the tributary watershed as well as 19 reaches on the main stem of the Big Muddy River. Part of the latter areas were outside of the area influenced by Rend Lake. A breakdown of the 84,700 acres that would be affected by flood control are shown in TABLE N-1 for each watershed. The Economic Research Service of the United States Department of Agriculture provided projections on land-use patterns, crop patterns, and yields for each of the watershed studies.

b. Flood Damages. Flood damages were determined for three stages of economic development: (a) existing development expected to exist at the start of the improvement (1980); (b) future development expected to exist without water resource development; and (c) future development expected to exist with improvement. Tangible damages were determined for the following damage categories: agricultural production; urban and scattered residences and commercial establishments; and roads, railroads, and bridges.

(1) Soil Conservation Service Methodology. Composite values of damageable crop and pasture land were developed for each stream reach studied. Basic damage rates for each crop, by month, were developed from data obtained by the Soil Conservation Service planning of similar size and type watersheds under Public Law 566. Monthly rates were weighted by the probability of monthly flood events to obtain the estimated percent damage to each crop. Damage rates consist of: (1) the gross value of the original crop, less production cost not yet incurred, (2) plus the cost incurred in producing an alternate crop, less the undamaged value of the alternate crop. Damage rates were weighted by crop distribution to arrive at a composite acre damage rate for selected depths of flooding. Additional damage estimates to roads and bridges and to sediment, swamping, and scour were determined for conditions without project from an analysis of data on inventory forms. An analysis was then made to determine the amount of damage without project construction that would be recoverable if corrective measures were installed. The following data for the latter category were furnished by the geologist and used in this determination:

	Percent Recovery			Years to Recover		
	Slight	Moderate	Severe	Slight	Moderate	Severe
Sediment	100	75	35	0	10	15
Swamping	100	80	50	2	5	10
Scour	100	100	100	0	3	5

Only the recoverable portion of the damage could be reduced by project measures. The nonrecoverable portion of the damage was held constant

TABLE N-1

Acres Affected by Flood Control Improvements

Watershed	Acres[a/]
Big Muddy[b/]	14,100
Casey Fork Creek	6,600
Cedar Creek	400
Crab Orchard Creek	4,500
Galum Creek	5,500
Gun Creek	900
Hurricane Creek	500
Kinkaid Creek	100
Lake and Pond Creeks	1,800
Little Muddy River	11,900
Lower Beaucoup	9,300
Lower Crab Orchard	2,500
Middle Fork Creek	11,300
Upper Beaucoup	7,600
Upper Big Muddy	7,700
TOTAL	84,700

a/ Includes 78,100 acres of existing cropland, pasture, and idle land; and approximately 6,600 acres of woodland, which will be converted to cropland.

b/ Big Muddy River floodplain downstream from Rend Lake Dam.

for each of the systems analyzed. Detailed study was undertaken in Little Muddy and Middle Fork watersheds to determine damage reduction benefits. In both of the watersheds, the intensity of the economic analysis approached that used in preparing watershed work plans. Reduction in all types of damage was based on accepted procedures and reflects the reduction in areas, depths, and duration of flooding, as determined by hydrologic and economic studies. The difference between the damage after the installation of each system of development and that before its installation constitutes the benefit from reduction in damage creditable to that system. Reductions in all other types of damage (sediment, swamping, and scour; urban and scattered residences and commercial establishments; roads, railroads, and bridges) in the watersheds not studied in detail were also based on relationships developed from analyzing the two watersheds where detailed studies were conducted. The basic relationship, which appeared to best measure the reduction in damage, was that of plotting the percent reduction in crop and pasture damage against the percent reduction in each of the other types of damage. The regression equation $y = a + bx$ was used to locate the lines.

(2) Corps Methodology. Damage to crops established by the Corps analysis was determined by the method developed by the Office, Chief of Engineers, and outlined in memorandum, ENGCW-E, 30 September 1966, subject: "Flood Hydrograph Damage Integration Method of Estimating Flood Damages in Agricultural Areas." In this method, crop damages were separated into: losses of "direct production investments" (DPI), to include variable costs of soil preparation, fertilizer, seed, weed control, and insecticide; and "loss of income" (LI), to include fixed annual charges and expected returns to the operator. Crop acres flooded versus percent chance of occurrence curves were developed from area-elevation curves computed from U.S. Geological Survey sheets and flood-frequency profiles. The average annual damage to farm sets and other rural dwellings was based on a field survey sampling of these developments along the main stem of Big Muddy River. The number of units subject to flooding was developed by count of units within the floodplain, shown on county maps published by the Illinois Department of Public Works in cooperation with the U.S. Department of Commerce and Bureau of Public Roads. Damages in 1970 prices to roads and bridges, fencing and ditches, and erosion and swamping, were based upon unit estimates of $1.05, $1.60, and $1.10 per acre, respectively.

c. Flood Damages Prevented. Average annual benefits for existing development are shown in TABLE N-2 and total $1,166,100. Benefits attributable to future development expected to exist without protection are shown in TABLE N-3 as damage reduction benefits of $245,000.

d. Increased Returns to Cropland. With flood protection provided, it is anticipated that the use of more intensive agronomic practices and conversion of timberland will occur, resulting in increased returns to land. Restoration of productivity on land previously rendered unproductive due to persistant damage will also

TABLE N-2

Average Annual Flood Control Benefits
Existing Development (1980)

Watershed	Damage Reduction
Big Muddy[a/]	$ 23,100
Casey Fork Creek	121,300
Cedar Creek	7,200
Crab Orchard Creek	41,800
Galum Creek	72,300
Gun Creek	30,800
Hurricane Creek	6,100
Kinkaid Creek	400
Lake and Pond Creeks	24,100
Little Muddy River	149,500
Lower Beaucoup	22,400
Lower Crab Orchard	4,100
Middle Fork Creek	190,200
Upper Beaucoup	174,200
Upper Big Muddy	298,600
TOTAL	$1,166,100

a/ Big Muddy River floodplain downstream from Rend Lake Dam.

TABLE N-3

Annual Flood Control Benefits
Future Development Without Improvement

Watershed	Damage Reduction
Big Muddy[a/]	$ 2,100
Casey Fork Creek	25,500
Cedar Creek	1,500
Crab Orchard Creek	8,800
Galum Creek	15,200
Gun Creek	6,700
Hurricane Creek	1,400
Kinkaid Creek	100
Lake and Pond Creeks	5,100
Little Muddy River	31,600
Lower Beaucoup	4,700
Lower Crab Orchard	2,100
Middle Fork Creek	40,400
Upper Beaucoup	36,800
Upper Big Muddy	63,000
TOTAL	$245,000

a/ Big Muddy River floodplain downstream from Rend Lake Dam.

occur with the protection provided by the improvements. The amount of changed land use expected as a result of reduced flooding was determined for the two reaches studied in detail by the Soil Conservation Service and appropriately related to other reaches under study. Anticipated changed land-use benefits are expected to accrue on 6,600 acres of flood plain land when protected by the considered improvements. Adjustments were made to gross benefits due to changed land use to account for: delay in accrual, damage to higher values, reductions for increased overhead and taxes, and cost of clearing and other land preparation costs. Average annual national benefits for the above categories for future development anticipated with project total $1,893,200 as shown in TABLE N-4.

e. Total Flood Control Benefits. Total flood control benefits including benefits creditable to existing development, future development without protection, and future development with protection, are shown in TABLE N-5 and total $3,304,300. A more detailed discussion of the analysis is presented in APPENDIX F, FLOOD CONTROL AND DRAINAGE.

11. DRAINAGE

Channel improvement will provide drainage relief in areas with inadequate drainage. These measures will result in greater agricultural productivity from lands subjected to chronic or intermittent flooding. Channel improvements and ditching programs will be coordinated with conservation agencies to assure preservation of associated fish and wildlife values. Yields expected to occur as a result of improved drainage were obtained from the Ohio River Basin Comprehensive Survey where yield capabilities were related to soil types. There was sufficient similarity between soil types in the two basins for correlation to be made. Individual crop yield increases, by soil types, were weighted with acreage of each crop to arrive at a composite yield for each watershed. (Cost data used in the drainage evaluation were based on data compiled by SCS.) The preliminary hydraulic screening reduced the area with economic potential for drainage improvements to 236,500 acres in the basin, which are shown by watershed in TABLE N-6. Gross benefits from drainage were discounted for delay in accrual and for less than full participation. In determining the amount of participation, consideration was given to: the average size farm unit in the benefited areas, amount of off-farm employment by farm operators, and the expectation that drainage improvements would require considerable acreage of small holdings. In view of these considerations, it was determined that the installation of on-farm drainage systems would be something less than that in areas of larger ownerships and full-farm employment. Consequently, in flood plain areas, a ten-year lag and 70 percent participation was used. In the non-flood plain areas, a five-year lag and 80 percent participation was considered more appropriate. Gross benefits were further reduced to account for the non-project costs associated with drainage improvements. These included the cost of installing on-farm drainage and the increased cost

TABLE N-4

Annual Flood Control Benefits
Future Development with Improvement

Watershed	Restoration of former productivity	Changed land use	More intensive land use	Total benefits
Big Muddy[a/]	-0-	-0-	-0-	-0-
Casey Fork Creek	73,700	12,000	112,300	198,000
Cedar Creek	-0-	-0-	-0-	-0-
Crab Orchard Creek	24,300	47,800	62,500	134,600
Galum Creek	37,300	56,600	65,700	159,600
Gun Creek	21,400	2,900	37,000	61,300
Hurricane Creek	11,800	5,200	14,900	31,900
Kinkaid Creek	-0-	-0-	-0-	-0-
Lake and Pond Creeks	37,400	13,200	54,400	105,000
Little Muddy River	64,900	32,800	160,900	258,600
Lower Beaucoup	-0-	-0-	-0-	-0-
Lower Crab Orchard	-0-	-0-	-0-	-0-
Middle Fork Creek	64,600	52,400	175,700	292,700
Upper Beaucoup	84,100	61,200	154,500	299,800
Upper Big Muddy	104,800	29,700	217,200	351,700
TOTALS	$524,300	$313,800	$1,055,100	$1,893,200

a/ Big Muddy River floodplain downstream from Rend Lake Dam.

TABLE N-5

Total Average Annual Flood Control Benefits

Watershed	Existing development	Future development without protection	Future development with protection	Total
Big Muddy[a/]	$ 23,100	$ 2,100	$ -0-	$ 25,200
Casey Fork Creek	121,300	25,500	198,000	344,800
Cedar Creek	7,200	1,500	-0-	8,700
Crab Orchard Creek	41,800	8,800	134,600	185,200
Galum Creek	72,300	15,200	159,600	247,100
Gun Creek	30,800	6,700	61,300	98,800
Hurricane Creek	6,100	1,400	31,900	39,400
Kinkaid Creek	400	100	-0-	500
Lake and Pond Creeks	24,100	5,100	105,000	134,200
Little Muddy River	149,500	31,600	258,600	439,700
Lower Beaucoup	22,400	4,700	-0-	27,100
Lower Crab Orchard	4,100	2,100	-0-	6,200
Middle Fork Creek	190,200	40,400	292,700	523,300
Upper Beaucoup	174,200	36,800	299,800	510,800
Upper Big Muddy	298,600	63,000	351,700	713,300
TOTALS	$1,166,100	$245,000	$1,893,200	$3,304,300

a/ Big Muddy River floodplain downstream from Rend Lake Dam.

TABLE N-6

Acres Affected by Drainage Improvements

Watershed	Floodplain acres	Non-floodplain acres	Total acres
Casey Fork Creek	7,800	13,100	20,900
Crab Orchard Creek	7,200	24,200	31,400
Gun Creek	1,000	6,700	7,700
Hurricane Creek	900	4,100	5,000
Lake and Pond Creeks	2,500	12,300	14,800
Middle Fork Creek	20,700	23,900	44,600
Upper Big Muddy	10,500	11,100	21,600
Galum Creek	8,000	7,000	15,000
Little Muddy River	26,600	20,700	47,300
Upper Beaucoup	13,100	15,100	28,200
TOTALS	98,300	138,200	236,500

of overhead and taxes. In the flood plain area, an additional reduction was necessary because of the affects of flooding on the increased productivity. This reduction for each watershed was equal to the percentage relationship between flood damages with and without project. It was considered that the area on the tributaries affected by two-year or less frequency flood from the river would not be benefited. Total benefits attributable to drainage improvements are shown in TABLE N-7 by damage area and total $1,008,400. A more detailed discussion of the analysis is presented in APPENDIX F, FLOOD CONTROL AND DRAINAGE.

TABLE N-7

Average Annual Drainage Benefits

Watershed	Primary Benefits
Casey Fork Creek	$ 107,300
Crab Orchard Creek	62,100
Gun Creek	36,500
Hurricane Creek	14,300
Lake and Pond Creeks	53,300
Middle Fork Creek	164,100
Upper Big Muddy River	212,100
Galum Creek	64,100
Little Muddy River	147,300
Upper Beaucoup	147,300
TOTAL	$1,008,400

12. GENERAL RECREATION

For the purpose of this report, the needs and accruable benefits in this category were limited to ten activities that are most popular with the majority of the recreationists. These activities include swimming, canoeing, sailing, boating, water skiing, picnicking, camping, sight-seeing, nature walks, and hiking. Three separate segments of population were expected to generate the demand for recreational opportunities within the basin. The first involved those people residing within the basin and whose usage would be essentially confined to day-use activities. The second segment comprised selected portions of six Standard Metropolitan Statistical Areas (SMSA) located within 125 miles of the basin. The six are: St. Louis, Missouri; Evansville and Terre Haute, Indiana; and Decatur, Springfield, and Champaign-Urbana, Illinois. Demand from these SMSA would be generated by those residents seeking diversified opportunities for weekend trips within two to three hours' driving time. The percentage of population involved

for each of the particular SMSA was varied in relation to the time-distance travel required. To this population base was added the impact induced by the three interstate highways and two national recreational corridors that will eventually traverse the basin. In this case, the recreationist would be engaged in vacation travel originating from beyond a three-hour driving distance. These people would be seeking partial or total satisfaction during their vacation travel. Although these vacationers will come from a very broad area, only those from the upper two-thirds of Illinois, the lower two-thirds of counties in Wisconsin, and the northwesternmost four counties of Indiana, were considered in this evaluation. In this particular part of the Upper Mississippi River Basin, there is a dearth of recreational opportunities requiring the residents to seek outside areas for vacationing. Based on past studies, it was estimated that approximately ten percent of the unsatisfied demand in those areas would be equivalent to the vacation travel originating therein. To be conservative, only 15 percent of this so-classified vacation-type demand was considered representative of those seeking possible recreational opportunities in southern Illinois and particularly, the Big Muddy Basin. Based on the foregoing, a total demand of some 6,400,000 recreational days was projected by 1980, increasing to approximately 10,800,000 by the year 2000, and reaching 15,100,000 by the year 2020. An inventory of existing and programmed resource developments was then completed to determine the capability of these projects in meeting the time-phased demands. The results indicated an unmet need of some 2,000,000 recreational days by 1980; 5,200,000 by the year 2000; and 8,400,000 by the year 2020. General recreation benefits were evaluated as equivalent to the estimated annual recreation day attendance times the unit value for the type of recreational activity(s) involved. The monetary unit value of benefits per recreation day would range from $0.75 to $1.50, dependent upon whether the opportunities are provided by strip-mine rehabilitation, reservoir construction, or environmental stream corridor development. If it is assumed that the bulk of demands would be satisfied by a reservoir program as implied by the amount of water surface required to meet these needs, 26,000 acres in 2020, the unit value of $1.00 would be applicable. Accordingly, the total discounted recreational benefits (2020 needs) are estimated at $4,875,600 annually of which 41 percent or $2,000,000 are creditable to the 1980 initial needs. Detailed evaluation of the foregoing is presented in APPENDIX H, PART II.

13. LOW-FLOW AUGMENTATION

Low-flow augmentation benefits represent the value of maintaining a specified level of flow quality and quantity in the major tributary streams. In all cases, benefits were based on the cost of the most likely alternative that local interests would undertake in lieu of the type of service under consideration for meeting the required needs. The one alternative for quality control acceptable to the State and most likely to be undertaken by local interests would be advanced

waste treatment. This was one of the few alternatives with the basic criterion of the equivalent service or function provided by increased flows; hence, it was retained and used as a basic equivalent measure of service. The only exception was in the West Frankfort, Illinois, area, where it was found to be more economical and just as effective for that community to pump its treated effluent to the main stem of the Big Muddy River where sufficient dilution flows are to be maintained by releases from the authorized Rend Lake Dam and Reservoir. In the environmental area of Carbondale, where low-flow augmentation is to be provided in the interest of base flow maintenance, the only feasible alternative would be construction of a single-purpose reservoir. The annual worth of supplementing stream flow for water quality control was based on the cost of providing the selected alternative, properly discounted to the base year. In the case of advanced waste treatment and pumping effluent, the benefits were computed as equivalent to the annual cost of meeting these needs using the required increments of development and operational charges. These values were based on an 8-1/4 percent non-Federal interest rate amortized over a period of 25 years and converted, using the Federal rate of 5-1/8 percent, to uniform equivalent series for the period equal to the project's economic life. The use of 8-1/4 percent interest rate for tax-exempt bonds was selected as the appropriate non-Federal interest rate to reflect the generally poor credit rating of communities in an economically depressed area. Average annual benefits attributable to the five load points, where low-flow augmentation in the interest of water quality is required, is estimated at $1,072,100 annually. Benefits creditable for maintenance of a base flow at Carbondale were computed equivalent to the annual cost of a single-purpose reservoir with staged construction to provide the projected supplementation. These values were derived using the Federal interest rate of 5-1/8 percent and amortized over a period of 100 years. The future incremental worth, including investment and annual operational charges, were converted to a uniform annual series during the period of project analysis. Average annual benefits attributable to maintenance of minimum base flow are estimated at $1,598,800 annually. Derivation of the individual benefits is shown in TABLE N-8. Detailed explanation of the technical and functional evaluation is presented in APPENDIX E, WATER USE AND STREAM QUALITY.

TABLE N-8

Derivation of Low Flow Benefits
(1970 dollars)

Watershed	Load Point	Applicable Type of Alternative	Demand Period	Need Period	Incremental Capital Cost, Present Worth, (1980 base) ($)	Discounted Annual Costs (1980 base), $/year Construction ($)	O&M ($)	Annual Cost ($)
6. Upper Beaucoup	Pinckney-ville	Advanced Waste Treatment	1980 2000	2000 2020	1,533,100 119,700	79,100 6,200	74,400 4,500	153,500 10,700 164,200
7a. Upper Crab Orchard Creek	Marion	Advanced Waste Treatment	1980 2000	2000 2020	2,236,200 117,000	115,400 6,000	104,700 5,300	220,100 11,300 231,400
7b. Lower Crab Orchard Creek	Carbondale	Single-Purpose Reservoir	1980 2000	2000 2020	8,920,000 1,320,000	460,300 24,800	41,600 --	501,900 24,800 526,700
8. Little Muddy River	DuQuoin	Advanced Waste Treatment	1980 2000	2000 2020	2,463,000 190,600	127,100 9,800	118,600 10,300	245,700 20,100 265,800
12. Middle Fork Creek	West Frankfort	Pipeline Effluent Transfer	1980 2000	2000 2020	430,000 363,000	29,200 15,000	27,000 9,700	56,200 24,700 80,900
15. Casey Fork Creek	Mt. Vernon	Advanced Waste Treatment	1980 2000	2000 2020	2,982,000 217,000	153,900 10,700	153,300 11,900	307,200 22,600 329,800
TOTAL								1,598,800

SECTION IV - REGIONAL ACCOUNT BENEFITS

14. NATURE OF REGIONAL BENEFITS

In addition to the foregoing benefits, developments--particularly reservoirs required to satisfy those needs listed in the national category--will serve as a catalyst for additional investment in the basin. These projects will "induce" investments to be made that will further stimulate the area's present depressed economy primarily by broadening its economic base and thereby raising the level of income. In order to quantify this induced impact, differentiation was made between those benefits that would accrue from expansion of the economic base structure and those that reflect a direct increase in income resulting from increased agricultural efficiencies.

15. DESCRIPTION OF EXPANSION PROCESS

A paper entitled "Reservoir Recreation and Local Economic Growth," contained in the ORRRC Study Report No. 24, analyzed the effects that reservoirs have on area's economic structure. To measure the expansion benefits that would result from a plan of improvement responsive to known needs, a case study was made of the Arkansas-Missouri-Ozark area on the White River, an area comparable to the Big Muddy Basin. The projects involved in the case study included the Norfolk, Bull Shoals, and Table Rock Reservoirs, all constructed by the Corps of Engineers. This particular area includes one privately constructed reservoir, Lake Taneycomo, where a limited recreational industry has been in operation for over 30 years; is within 50 miles of a large Missouri State Park; and includes some of the same population centers in its recreation-service areas as the Big Muddy Basin reservoir. The Big Muddy River Basin partially or totally includes one non-Federally constructed lake; the Shawnee National Forest area; the Crab Orchard complex;[1/] the Rend Lake Reservoir currently under construction by the Corps of Engineers; and Kinkaid Lake, also a Federal-State project currently under construction. It is considered that the growth factors applicable to the example region selected from the ORRRC study are indicative of the growth factors which will pertain to the Big Muddy Basin. The reservoirs will act as catalysts in attracting outside dollars to the area and putting them to work in an economically productive manner. The necessary capital for the most part comes from outside the local communities and thus starts the process of growth, which local leaders in the area have so long sought. The economic impact of a new water-related development makes itself felt locally in five phases:

a. Land Speculation. Once the development is completed and in operation, land values become greatly enhanced. This enhancement reflects the demand for acreage that could be used for commercial, industrial, and residential development.

1/ Lakes in this complex include: Little Grassy, Devil's Kitchen and Crab Orchard.

b. Tourism. Growth of the recreational industry will lead to increased employment and income in the area. The benefits will accrue to the local economy from money spent by tourists at or near the reservoirs and the additional income and spending generated by the initial expenditures.

c. Residential Development. Once project construction is underway, newcomers, individuals, or realtors, will develop the area around the lake. Real estate and local construction industries boom. Today most of these homes are not just the vacation cabin type, but usually are built for year-round use, by families who are attracted to the area by new jobs as well as those who continue to live in nearby cities and who want a place of their own in or around a particular body of water. Too, an increasing number of homes are being built for retired or semi-retired couples who move to the area for permanent residence. An example in the State of Missouri is the town of Branson near the Bull Shoals, Table Rock, and Norfolk Reservoir complex on the White River.

d. Shift in the Economic Structure of Nearby Towns. As economic development progresses, the area's towns begin to undergo a basic shift in their economic structure. They will change from essentially a dual-based economy devoted to serving small farms with low income and a decreasing segment of the population in mining activities, to one that is diversified and provides goods and services comparable to urban standards. Local towns and existing businesses start needed improvements, and new enterprises arrive and add to the revised economic structure.

e. Construction Payroll. The construction associated with the new developments attracted to the area introduces new payroll monies into the area. The recipients of these new monies will spend a large portion of their income in the local area. This process will be carried on many times, with the result that the original expenditure will multiply throughout the basin.

16. BASIS FOR EVALUATION OF EXPANSION BENEFITS

The basic unit used to measure the rate of economic growth was the county, for the practical reason that economic statistics were available. While the economic impact does not extend uniformly over the county as a whole, the use of statistics for the county will tend to understate the actual effects of economic stimulation on the towns in areas closest to bodies of water. Five different indices were identified in the case study as reflective of the resultant growth: population, employment, annual per capita income, annual wages and salaries, and bank deposits. For the purpose of this evaluation, the changes reflected in bank deposits were used as the basis to eventually quantify the effect of the expanded economic base that could be

anticipated in the Big Muddy Basin. This indicator was used because, more than any others, it easily permitted a separation of those induced (expansion) benefits creditable to the current projects from any future projects selected for implementation in this study. According to the ORRRC study, an average annual incremental growth in bank deposits of 4.5 percent was found to have occurred for the counties with water developments. This figure was based on the comparative difference in the rate of growth for those counties that did not have any reservoirs, but were adjacent to counties which had one or more reservoirs. In determining the total or composite value of economic growth, it was felt that the development due to the bodies of water themselves should be limited by a time factor. This time limitation would be reflective of the fact that the economic expansion in itself would start a second round of expenditures not strictly applicable to the water-related developments, but somewhat secondary in nature. Therefore, it was estimated that the direct overall impact would most likely last approximately 20 years. This allows a sufficient period for the initial impact of the reservoirs to occur throughout the study area. The total resultant expansion benefits, however, attributable to a plan of improvement responsive to satisfying future needs, would have to be quantified by deletion of those values induced by projects presently under construction. Consequently, the local economic development benefits that would accrue to the area for the time period 1970 to 1980, would be creditable essentially to Rend Lake, Kinkaid Lake, and other land-related developments. Those benefits that would result from any future action program would be restricted to those that would accrue in the period of 1980-1990. After 1990, it was considered that the economic effects attributable to the man-made bodies of water would cease acting as the primary economic impact encouraging local growth. These local development benefits were considered to have an area-wide effect due to the relatively small size of the study area and the nature of the area-wide economic growth, and therefore the benefits were not prorated to the various watersheds.

17. VALUE OF EXPANSION BENEFITS

TABLES N-9 and N-10 present the procedures utilized to estimate the economic benefits which will accrue to the basin as a result of the induced investment improvement. Bank deposits in the basin were projected on a straight line basis to 1980 utilizing the rate of growth experienced during the period 1963 to 1968 but expressed in 1970 dollars. This method of projection was used since the impact attributable to those water- and land-related developments presently under construction was discernable in the 1963-68 rate of deposit growth. The projected deposits for 1980 were then used as a base and the resultant economic development impact determined using the 4.5 percent growth factor. This ten-year cumulative value was then discounted to determine the average annual worth over 100 years. This annual discounted net worth was equivalent to $12,604,000 (see TABLE 9) and represents a measure of incremental wealth that would accrue to the area as a

TABLE N-9

Area Reorientation - Assessment of Local Economic Impact
(All Costs in $1,000)

County	Deposits on hand (1968)[a/]	Projected deposits (1980)[b/]	% of county in basin	Amount of deposits applicable for evaluation	Annual growth (5)=(4)x4.5%	Annual equivalent benefits (5 1/8% @ 100 yrs)[c/]
	(1)	(2)	(3)	(4)	(5)	(6)
Franklin	$77,890	$187,520	98	$183,770		
Jackson	83,683	176,317	86	151,633		
Jefferson	76,330	291,167	78	227,110		
Perry	32,909	59,451	95	56,478		
Williamson	53,111	76,218	72	54,877		
Hamilton	16,811	33,154	10	3,315		
Johnson	13,010	30,768	1	308		
Marion	99,121	217,130	1	2,171		
Union	26,631	57,095	13	7,422		
Washington	32,627	74,653	27	20,156		
TOTAL				$707,240	$31,826	$12,604

a/ Actual 1968 deposits on hand (can be converted to 1970 by multiplying total by 1.10).
b/ Based on annual increase in deposits from 1963 to 1968 utilizing 1970 dollars (GNP implicit price deflator).
c/ Reflects continuous growth over 10 years, discounted and amortized at 5 1/8% over 100-year period.

TABLE N-10
Derivation of Gross and Net Benefits
Personal Income

$$\frac{\text{Personal Income (5 counties) 1970}}{\text{Total Deposits (5 counties) 1970}} = \frac{\$934,570,000}{\$265,855,000} = 3.52$$

$$\frac{\text{Personal Income (U.S.) 1970}}{\text{Total Deposits}} = \frac{\$803.3 \text{ Billion}}{\$369.9 \text{ Billion}} = 2.17$$

Projected Ratio 1980-1990 assuming Big Muddy Region assumes parit
U.S. in 2030:

$$\frac{3.52 - 2.17}{60} = \frac{1.35}{60} = .0225 \text{ decline per year}$$

$$\frac{3.295\ (1980) + 3.070\ (1990)}{2} = 3.18 \text{ average ratio 1980-1990}$$

Average personal income growth Big Muddy Region 1980-1990 gross b
Income deposit multiplier x average annual discounted change
deposits (TABLE N-9) = 3.18 x $12,604,000 = $40,100,000

Net benefits attributable to reservoir:
Gross benefits x 33 1/3 = $40,100,000 x .33 1/3 = $13,400,00

result of the expanded economic base. This increase in deposits, a measure of wealth, was then translated into an annual income flow since changes in income reflect the totality of the induced changes in the economy. This measure, personal income, is generally accepted by welfare economists as the best measure of economic benefits. The procedures utilized to make this conversion are presented in TABLE N-10 and are as follows:

a. The personal income to deposit ratio was computed for the basin area and the United States. Assuming that the basin achieves parity with the U.S. in 2030, the income to deposit ratio was projected to average 3.18 during 1980-1990.

b. The average annual discounted change in deposits, $12,604,000 was then multiplied by the projected 1980-1990 income to deposit ratio yielding an annual discounted growth in personal income of $40,100,000 during the one decade under consideration. This growth in personal income represents the gross benefits attributable to future development. In order to arrive at a net benefit figure, it was necessary to separate the growth in income attributed directly to water-related development and that attributable to other public and private investment. The latter investments, including those required for the five phases in which the economic impact will be felt, are estimated to be twice the magnitude of the investment required in a typical water-related development. Based upon this judgment consideration, it was concluded that for every dollar invested in a reservoir, an additional two dollars will be invested in residential, commercial, and industrial as well as local public facilities. Thus, the net benefits applicable to future projects are estimated at $13,400,000 annually.

18. CONFIRMATION OF EXPANSION BENEFITS

In order to verify the validity of the foregoing benefits, a separate study of the recreation-related industry was undertaken since it represents an important segment of the potential economic growth. If sufficient water surface or reservoirs are provided to meet the projected recreational needs, the resultant tourism impact will be significant in its contribution to the basin's economy. The local economic impact attributable to tourism will be generated in two parts: the income that would accrue to the local economy from the money spent by the recreationists at the reservoirs, and the value of recreation business as a stimulus to the total local economy in terms of new jobs and special services. To determine the wages that would accrue to the local economy from the money spent by the recreationists at the reservoirs, information and study data contained in the paper entitled "Private and Public Provision of Outdoor Recreation Opportunity," printed in the ORRRC Study Report No. 24, were used. The paper contained estimated expenditure per person per day for visitors to specified kinds of public recreational areas. For the purpose of this report, the breakdown of costs for visitors using Federal reservoirs built by the Corps of Engineers and Tennessee Valley Authority was used. Of the

total estimated daily expenditure of $9.75 (1960 price leve
report used only that portion of the cash outlay made durin
mediately preceding the visit for food, lodging, transporta
miscellaneous items. Reasonable charges for use of equipme
as automobiles, boats, etc., equal to $4.50 (1960 price lev
deleted from the consideration since the probable location
expenditures was shown to vary greatly according to the typ
visited. For the purpose of this report, only that percent
monetary outlay spent in or near the project area was used.
was found (see TABLE N-11) that the tourist spent $2.11 in
reservoir. Once the expenditure by the tourist in the gene
was known, a division of the money spent according to the o
requirements of the recipient was determined. From this br
costs incurred by the business operators, it was found that
of the $2.11 accrued as local income. In 1970 dollars, thi
to $.98. These data are summarized in TABLE N-11. Of the
penditure per recreationist per visitor day, $.98 resulted
income to workers and proprietors in the area of the reserv
factor together with the projected recreational needs were
to determine the applicable annual average personal income
as shown in TABLE N-12. However, an increase in income ass
development of the tourism industry produces growth in othe
of the local economy. This relationship has been the subje
siderable research. Based upon a technique developed by Ro
Nathan and Associates, Inc.,[2/] it was concluded that for ev
of income generated by tourism in southern Illinois, an add
$1.03 of income is generated in other sectors. Thus, the t
and indirect local income attributable to recreation was es
be $9,699,500. Of the total local income attributable to t
$1,552,000 or 16.3 percent represents the return on investe
This percent was derived by assigning one-half of the owner
(TABLE N-11, col. 3b) to return on invested capital and the
ting this value monetarily by following the same procedure
above. Only one-half of the owner's return was used becaus
the recreation industry consists of proprietor-managed firm
of the proprietor's income in reality wages. Average annua
fits (i.e. excluding returns to capital) to tourism were th
to be $9,699,500 less $1,552,000 or $8,147,500. Of the tot
pansion benefits of $13,400,000 outlined above in Paragraph
attributable to expenditures of recreationists accounted fo
This amount is consistant with the relative importance of t
the recreation industry in previously cited areas of simila

19. AGRICULTURAL RELATED BENEFITS

Regional agricultural benefits are those benefits whic
a result of the decrease in uncertainty associated with flo

2/ Nathan, R. R. and Associates, Appalachian Research Repo
reation as an Industry, Washington, D. C., December 196
106. It should be noted our multiplier is almost identi
that developed by Nathan for counties of similar size.

TABLE N-11

Income Component of Tourist Dollar[a/]

Item of Expense		Estimated Expenditure per capita per day 1960 (1)	Est. Expenditure at Reservoir (2)	Percent of Rec. Expend. According to Recipient of Money: Goods (3a)	Owners (3b)	Wages (3c)	Other (3d)	Local Income 1960[b/] (4)	Local Income 1970[c/] (5)
Food	In restaurants	$1.00	$ .65	52	8	20	20	$.247	
	From groceries	1.00	.10	85	5	5	5	.013	
Lodging		.50	.30	25	15	30	30	.180	
Transportation	Gas & Oil	1.00	.25	75	8	8	9	.051	
	Other	.25	.06	65	10	10	15	.016	
Miscellaneous (other)		1.50	.75	60	15	7	18	.232	
Subtotal		$5.25	$2.11					$.739	$.98

a/ Based on data contained in ORRRC Study Report No. 24.
b/ Local income equals column 2 times (col. 3b + col. 3c + 1/2 col. 3d).
c/ Reflects the increase in value from 1960 to 1970 price levels by use of consumer price index.

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COMPREHENSIVE BASIN STUDY. BIG MUDDY RIVER, ILLINOIS. VOLUME 7.--ETC(U)
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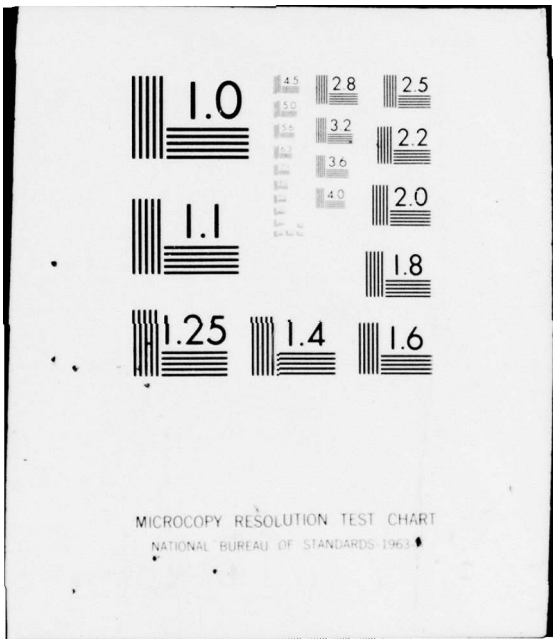
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4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE N-12

Increase in Personal Income Generated by Tourist Dollar

Year	Average Annual Visitor Days (1)	Income/ Visitor ($.98 x Col 1) (2)	Present Worth Factor 5 1/8% (3)	Present Values of Income (Col 2 x Col 3) (4)
1980-1990	2,800,000	$2,744,000	.779	$ 2,137,600
1990-2000	4,400,000	4,312,000	.473	2,039,600
2000-2010	6,000,000	5,880,000	.287	1,687,600
2010-2020	7,600,000	7,448,000	.174	1,296,000
2020-2030	8,400,000	8,232,000	.105	864,400
2030-2040	8,400,000	8,232,000	.064	526,800
2040-2050	8,400,000	8,232,000	.039	321,000
2050-2060	8,400,000	8,232,000	.024	197,600
2060-2070	8,400,000	8,232,000	.014	115,200
2070-2080	8,400,000	8,232,000	.009	74,100
				$ 9,259,900
Years (to convert above decades into 100 years)				x 10
Cumulative direct increase in personal income				$92,599,000
Interest and ammortization factor (100 years @ 5 1/8% interest)				.0516
Average annual direct increase in personal income				$ 4,778,100
Income multiplier				2.03
Average annual direct and indirect increase in personal income				$ 9,699,500

and other aspects of the food and fiber production. With the decline in risk, there will be a corresponding rise in capital outlays for farm improvements, fertilizers, and machinery which will increase productivity and give rise to a growth in local agri-business. The value of this benefit category has been estimated as equivalent to ten percent of the creditable worth for flood control and drainage improvements. Total agricultural-related regional benefits are thus estimated at $431,300 (see TABLE N-13).

TABLE N-13

Agricultural-Related Induced Benefits

	Watershed	Benefits
1&9	Big Muddy	$ 2,500
2	Cedar Creek	900
3	Kinkaid	100
4	Lower Beaucoup	2,700
5	Galum Creek	31,100
6	Upper Beaucoup	65,900
7A	Crab Orchard Creek	24,700
7B	Lower Crab Orchard	600
8	Little Muddy River	58,800
10	Hurricane Creek	5,300
11	Lake and Pond Creeks	18,700
12	Middle Fork Creek	68,700
13	Gun Creek	13,600
14	Upper Big Muddy River	92,500
15	Casey Fork Creek	45,200
	TOTAL WATERSHED	$431,300

SECTION V - SUMMARY OF BENEFITS

20. SUMMARY OF BENEFITS

Total average annual benefits creditable to the various watersheds and the basin are estimated at $24,618,400 and are detailed in TABLE N-14. Of this total 44 percent are classified as national benefits and include flood control, drainage, and low-flow augmentation, and general recreation. These benefits increase the value of the nation's output of goods and services thereby improving the national economic efficiency. The remaining benefits, 56 percent, are essentially local and will arise as this underdeveloped region's economy expands in response to the stimulus of new water-related projects. This stimulus will occur directly from the growth of new activities as well as investment which is induced into the area. Other intangible benefits which have not been quantified will accompany the economic growth of the region. For example, the out-migration pattern of the basin will be reversed and therefore ameliorate the population pressures in nearby metropolitan areas. In addition, the entire U.S. economy, particularly nearby metropolitan areas, will benefit from the increased demands for goods and services emanating from the expanded economy of the Big Muddy Basin. Finally, new projects will provide the supplemental stimulus to the present ongoing investments necessary to allow the basin's economy to approximate parity with the nation.

TABLE N-14
Average Annual Benefits (Dollars)[a/]

		National Benefits										Regional Benefits		
		Flood Control												
	Watershed	Existing Development	Future Development	Restoration of Productivity	Changed Land Use	More Intensive Land Use	Total Flood Control	Drainage	Low-Flow Augmentation	General Recreation[b/]	Total National Benefits	Local Economic Development	Agricultural Related Regional	Total National and Regional
169	Big Muddy	23,100	2,100				25,200				25,200		2,500	27,700
2	Cedar Creek	7,200	1,500				8,700				8,700		900	9,600
3	Kinkaid	400	100				500				500		100	600
4	Lower Beaucoup	22,400	4,700				27,100				27,100		2,700	29,800
5	Galum Creek	72,300	15,200	37,300	56,600	65,700	247,100	64,100			311,200		31,100	342,300
6	Upper Beaucoup	174,200	36,800	84,100	61,200	154,500	510,800	147,300	164,200		822,300		65,900	888,200
7A	Upper Crab Orchard Cr.	41,800	8,800	24,300	47,800	62,500	185,200	62,100	231,400		478,700		24,700	503,400
7B	Lower Crab Orchard Cr.	4,100	2,100				6,200		526,700		532,900		600	533,500
8	Little Muddy River	149,500	31,600	64,900	32,800	160,900	439,700	147,300	265,800		852,800		58,800	911,600
10	Hurricane Creek	6,100	1,400	11,800	5,200	14,900	39,400	14,300			53,700		5,300	59,000
11	Lake and Pond Creeks	24,100	5,100	37,400	13,200	54,400	134,200	53,300			187,500		18,700	206,200
12	Middle Fork Creek	190,200	40,400	64,600	52,400	175,700	523,300	164,100	80,900		768,300		68,700	837,000
13	Gun Creek	30,800	6,700	21,400	2,900	37,000	98,800	36,500			135,300		13,600	148,900
14	Upper Big Muddy River	298,600	63,000	104,800	29,700	217,200	713,300	212,100			925,400		92,500	1,017,900
15	Casey Fork Creek	121,300	25,500	73,700	12,000	112,300	344,800	107,300	329,800		781,900		45,200	827,100
	TOTAL WATERSHED	1,166,100	245,000	524,300	313,800	1,055,100	3,304,300	1,008,400	1,598,800		5,911,500		431,300	6,342,800
	TOTAL BASIN									4,875,600[c/]	4,875,600	13,400,000		18,275,600
	TOTAL WATERSHED AND BASIN BENEFITS	1,166,100	245,000	524,300	313,800	1,055,100	3,304,300	1,008,400	1,598,800	4,875,600[c/]	10,787,100	13,400,000	431,300	24,618,400

a/ Reflects a Federal interest rate of 5 1/8 percent.
b/ These types of benefits are not creditable to individual watershed since they are based on the needs of the whole basin.
c/ Estimates of benefits have been based on the unit value per recreation day of $1.00 which is representative of the worth for reservoir related usage. Final worth will be dependent upon allocation of projected needs creditable to usage of the stream corridors which have a unit value of $1.50 per recreation day.

FORMAL COMMENTS

APPENDIX N

United States Department of the Interior

OFFICE OF THE SECRETARY
UPPER-MISSISSIPPI WESTERN GREAT LAKES AREA
2510 DEMPSTER STREET
DES PLAINES, ILLINOIS 60016

January 14, 1971

Colonel Carroll N. Letellier
District Engineer
U. S. Army Engineer District,
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Letellier:

I have reviewed the revised version of Appendix N, Benefit Evaluation, to the Big Muddy River, Illinois, Comprehensive Basin Study. The Appendix reflects the reevaluations and revised interest rates and has been approved by the Coordinating Committee. I believe it adequately portrays the benefits which can be expected by adoption of the plan.

Very truly yours,

Burton H. Atwood

Burton H. Atwood
Field Representative
North Central Region

United States Department of the Interior

BUREAU OF MINES

Twin Cities Mineral Supply Field Office
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

February 5, 1971

Colonel Carroll N. LeTellier
Chairman, Coordinating Committee
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

We have reviewed the final field versions of Appendix H, Part 2 - General Recreation and Appendix N - Benefit Evaluation of the Big Muddy River, Illinois, Comprehensive Basin Study and have no changes to suggest.

Very truly yours,

Matthew G. Sikich

Matthew G. Sikich
Acting Chief

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
NORTHEAST REGION
143 SOUTH THIRD STREET
PHILADELPHIA, PA. 19106

IN REPLY REFER TO:
L7423
NER(CP)

January 15, 1971

Colonel Carroll N. LeTellier
District Engineer
Chairman, Coordinating Committee
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

I have reviewed Appendix H - Recreation and Appendix N - Economic Evaluation, Big Muddy River Comprehensive Basin Study. I have no comments on either appendix.

Sincerely yours,

Harold I. Lessem

Harold I. Lessem
Federal Liaison
Federal, State & Private Agency Assistance

United States Department of the Interior

IN REPLY REFER TO

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

[illegible] Area Office - Div. RBS
Federal Bldg., Fort Snelling
Twin Cities, Minnesota 55111

January 19, 1971

AIR MAIL

Col. Carroll H. LeTellier
District Engineer
U. S. Army Engineer District
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier: Your Ref.: LMSED-BG

The following information is provided in response to your January 7, 1971 request for field level comments on Appendix N, Benefit Evaluation, Big Muddy River Comprehensive Basin Study, Illinois.

In Section I, Paragraph 3 (Results of Need Evaluation) the Appendix indicates that there are certain items "incapable of being quantified monetarily at this time (intangible benefits) etc.". Improvement to stream fishery is one of the described items which are to be later presented in Appendix M, Plan Formulation. The stream fishery benefits which we credited to this project in Mr. Jorgensen's October 27, 1970 letter to you are of a tangible nature. Therefore, we suggest that any benefits attributed to an improved stream fishery be treated as tangible benefits, using the monetary values previously supplied by the Bureau of Sport Fisheries and Wildlife.

On Page 6, under Item (2) d. Increased Returns to Cropland, sentence 1, the following statement appears:

"With flood protection provided, it is anticipated that the use of more intensive agronomic practices and conversion of timberland will occur, resulting in increased returns to land." Conversion of timberland (to agriculture) entails an almost certain loss of wildlife habitat, together with attendant losses of other natural values, including forest, esthetic and flood detention values. Therefore, it does not necessarily follow that conversion of timberland will automatically result in increased returns to land. Accordingly, it is suggested that Table N-4 (Annual Flood Control Benefits) be re-examined

and the indicated benefits adjusted downward to reflect this consideration.

We appreciate the opportunity to provide the field level review comments.

Sincerely,

Donald B. Vogtman

Donald B. Vogtman
Supervisor

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

LMSED-BG

22 February 1971

Mr. Donald B. Vogtman, Supervisor
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

Dear Mr. Vogtman:

This is to acknowledge receipt of your letter, dated 19 January 1971, furnishing the Coordinating Committee your agency's comments on Appendix N, Benefit Evaluation, Big Muddy River, Illinois, Comprehensive Basin Study.

As noted, the tangible benefits furnished by your office relative to stream fishing, have not been included in this appendix. It was felt that since the major portion of benefits creditable to the establishment of the recreational-environmental corridors were of an intangible nature, any discussions of the applicable benefits should be treated in toto and therefore were included in Appendix M.

It is acknowledged that conversion of timberland to agricultural usage will result in certain losses to existing wildlife habitat and other natural values, including forests, esthetics, and flood detention values. In evaluating the increased returns to cropland, it is significant to note that this potential adverse effect was kept to a minimum in the planning effort and only 6,600 acres are envisioned to be converted throughout the total basin. As is noted in Appendix K, the changed land use is an incidental result of flood control, generally coming from small areas of pasture, forests, and idle land. Your concern, however, was subsequently reflected in the trade-off detailed in Appendix M, wherein proposed drainage improvements for agricultural enhancement in the Little Muddy Watershed were deleted in favor of establishing a recreational-environmental corridor initially dedicated for fish and wildlife conservation and enhancement. As a result, this, plus other modifications for environmental improvements and social well-being purposes, have resulted in a balanced plan of improvement responsive to the total spectrum of needs.

Sincerely yours,

CARROLL N. LeTELLIER
Colonel, CE
District Engineer
Chairman, Coordinating Committee

United States Department of the Interior

GEOLOGICAL SURVEY
2222 Schuetz Road, Suite 212
St. Louis, Missouri 63141

February 5, 1971

Your ref: LMSED-BG

District Engineer
St. Louis District
U. S. Army Corps of Engineers
210 N. 12th Street
St. Louis, Missouri 63101

Dear Sir:

This is to acknowledge receipt of the final field version of Appendix N, Benefit Evaluation, of the Big Muddy River Comprehensive Basin Study. The U. S. Geological Survey has reviewed this appendix and finds no conflict with the information gathered in our studies of ground water and geology.

Sincerely yours,

Elwood R. Leeson
Regional Hydrologist, MCR
Water Resources Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
LAKE CENTRAL REGION
3853 RESEARCH PARK DRIVE
ANN ARBOR, MICHIGAN 48104

D6427UM
Big Muddy

February 5, 1971

District Engineer
U. S. Army Engineer District,
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Sir:

In response to your letter of January 7, 1971, we have reviewed the final field version of Appendix N, Benefit Evaluation, to the Big Muddy River Comprehensive Basin Study, Illinois, and the following comprise our formal field level comments.

This office, with the cooperation of an interagency Recreation Committee, developed the recreation demand, supply, and needs analysis for the basin and we do not question the general recreation benefits shown in Appendix N. We believe they are reasonable. Nevertheless, in a study such as this it does appear presumptuous for recreation to attain preeminent rank among the primary or national economic benefits.

In the ninth line of paragraph 12 on page 16, change "lower two thirds" to "lower two tiers."

Sincerely yours,

ROMAN H. KOENINGS
Regional Director

By: Robert H. Myers
Robert H. Myers
Acting

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service Central Region
Room 1836, 601 E. 12th Street
Kansas City, Missouri 64106

February 5, 1971

WFC2

District Engineer
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Subject: Big Muddy River Comprehensive Basin Study

Reference: LMSED-BG

Dear Sir:

Appendix N, Benefit Evaluation, has been reviewed and I have no comments on this phase of the study.

Very truly yours,

VERNE ALEXANDER
Regional Hydrologist

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P.O. Box 678, 200 W. Church St., Champaign, Illinois 61820

January 20, 1971

Colonel Carroll N. LeTellier
District Engineer - LMSED-BG
U. S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

The Forest Service, Economic Research Service, and Soil Conservation Service have reviewed the final field version of Appendix N, Benefit Evaluation for the Big Muddy River Comprehensive Basin Study. Since this document is essentially the same as previously reviewed, we have no additional comments to make.

We appreciate the opportunity to review and comment on this final field version.

Sincerely,

Howard W. Busch acting
State Conservationist

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION V
433 WEST VAN BUREN STREET, ROOM 712
CHICAGO, ILLINOIS 60607
PUBLIC HEALTH SERVICE

February 5, 1971

Your Reference: LMSED-BG

Colonel Carroll N. LeTellier
District Engineer
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Reference is made to your recent letter concerning the final field version of Appendix N, "Benefit Evaluation" to the Big Muddy River, Illinois, Comprehensive Basin Study.

Please be advised that this office has completed a cursory review of the above-mentioned appendix and that we do not have comments of substantial significance at this time.

Sincerely yours,

Donald W. Marshall

Donald W. Marshall, P.E.
Sanitary Engineer Director
U. S. Public Health Service

FEDERAL POWER COMMISSION
REGIONAL OFFICE
610 South Canal Street, Room 1051
Chicago, Illinois 60607

January 13, 1971

Colonel Carroll N. LeTellier
Chairman, Big Muddy River, Ill.
Coordinating Committee
District Engineer
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Receipt is acknowledged of your letter dated January 7 enclosing the final field version of Appendix N, Benefit Evaluation, to the Big Muddy River, Illinois, Comprehensive Basin Study. I have reviewed this report with much interest and have some reservations with regard to the discussion of regional benefits. As I have stated in our meetings, these regional benefits are what used to be known as secondary benefits in some circles. Complete treatment of such benefits should take account of the fact that they may be garnered at the expense of other segments of the economy or other regions. The effort should be to arrive at a net benefit applicable to the projects in question. This does not seem to be recognized or mentioned in the treatment of regional benefits.

Nevertheless, I have no objection to the inclusion of regional benefits if in other appendices of the report the benefit-cost ratios are clearly set out for national benefits alone and, if it is then deemed desirable, another benefit-cost ratio can be drawn on the basis of national plus regional benefits. However, these regional benefits must be clearly defined as those which might accrue to the region in question at the expense, at least in part, of regional benefits that might be reaped elsewhere through an alternative investment.

Sincerely yours,

Lenard B. Young

Lenard B. Young
Regional Engineer

UNITED STATES OF AMERICA
ENVIRONMENTAL PROTECTION AGENCY
REGION V
WATER QUALITY OFFICE
33 East Congress Parkway
Chicago, Illinois 60605

January 22, 1971

Colonel Carroll N. LeTellier
District Engineer
U. S. Army Engineer District,
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

The final field version of Appendix N, Benefit Evaluation, Big Muddy River, Illinois Comprehensive Basin Study, has been reviewed. Since there has been input by this agency into the appendix through review and revisions of previous drafts, I concur in its approach to the analysis of benefits from low-flow augmentation recognizing that there must be a full evaluation of the water quality management program at the time any project studies are accomplished.

However, the final version of Appendix H, states that part of the recreational benefits will be generated by the use of the stream corridors and footnote C to Table N-14 also recognizes this. Since the benefits from flow augmentation in this basin are realized through fishery and recreation users, I feel it is relevant to caution that there may be some overlap of benefits. This issue will hopefully be clarified through the new procedures being prepared by the Water Resources Council and its application in project design will clarify this issue.

Sincerely yours,

Francis T. Mayo
Regional Director

RICHARD B. OGILVIE
Governor

RAY C. DICKERSON
Director

STATE OF ILLINOIS
DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

February 11, 1971

Colonel Carroll N. LeTellier
District Engineer
Department of the Army
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel LeTellier:

Reference is made to your letter of January 7, 1971, File LMSED-BG asking for State comment on the final field version of Appendix N, Benefit Evaluation, for the Big Muddy River Comprehensive Basin Study.

The Natural Resource Development Board has reviewed the report and has no adverse comment to make at this time. However, we wish to advise that the Department of Conservation will not be in a position to render its opinion on this report for some three to six months.

Sincerely,

Ray C. Dickerson

Ray C. Dickerson